GJO-113(84)

1983 ENVIRONMENTAL MONITORING REPORT U.S. DEPARTMENT OF ENERGY FACILITIES GRAND JUNCTION, COLORADO, AND MONTICELLO, UTAH

Bendix Field Engineering Corporation
Grand Junction, Colorado

March 1984

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY
Assistant Secretary for Nuclear Energy
Grand Junction Area Office, Colorado

Available from: Technical Library
Bendix Field Engineering Corporation
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Grand Junction, CO 81502-1569

Telephone: (303) 242-8621, Ext. 278

Price per Microfiche Copy: $4.50

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March 1984

Prepared for the U.S. Department of Energy
Assistant Secretary for Nuclear Energy
Grand Junction, Colorado, Area Office
Under Contract No. DE-AC07-76GJ01664

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The shallow gravel aquifer that underlies the Grand Junction, Colorado, Department of Energy (DOE) facility is contaminated by uranium mill tailings. Uranium, molybdenum, arsenic, and selenium are all found in significantly elevated concentrations. For example, the Safe Drinking Water Act has set limits of 0.05 mg/l arsenic and 0.01 mg/l selenium. Both of these limits are regularly exceeded in groundwater samples collected within 6 meters of the Gunnison River. Selenium levels slightly exceed 0.01 mg/l, but arsenic levels have been as high as 0.4 mg/l. There are no standards promulgated for molybdenum, but the National Academy of Sciences (1972) has suggested a limit of 0.01 mg/l for agricultural use. Wells along the perimeter of the facility, many within a few meters of the river, contain approximately 0.2 mg/l molybdenum, and one well near the buried tailings area contains 0.7 mg/l. Uranium levels correlate well with those of molybdenum except that they are significantly greater, with several wells on the river dike containing more than 1 mg/l.

Surface water on the facility consists of two lagoons and a drainage ditch. The most serious contamination detected in 1983 was radium-226 in the ditch adjacent to the river dike. Results of the December sampling indicate a radium-226 concentration in the ditch of 59 pCi/l compared with the standard for drinking water of 5 pCi/l.

Twice during the year samples were collected from the Gunnison River. In neither instance were uranium-related contaminants detected in the samples. Thus, the effect of the contaminated aquifer on the river is assumed to be negligible; however, this cannot be verified without additional testing.

In addition to the contaminants discussed above, the presence of polychlorinated biphenyls (PCBs) is addressed in this report. Transformers on the facility have been properly labeled, and a small amount of PCB-contaminated waste has been disposed of. Finally, because there have been no significant process changes and no air-quality impacts reported in previous years, air-quality data were not obtained in 1983.

MONTICELLO MILLSITE

The shallow aquifer underlying the Monticello, Utah, DOE property is also contaminated by uranium mill tailings. The creek flowing through the property is contaminated at levels exceeding State of Utah water-quality standards for several kilometers downstream from the property. Contamination in Montezuma Creek results from seeps issuing from the contaminated alluvial aquifer; this seepage causes the uranium concentration in the creek to increase by as much as an order of magnitude. Concentrations as high as 0.51 mg/l were detected 30 meters from the Government property in 1983. Similarly, selenium concentrations regularly exceed 0.01 mg/l, the Utah standard for this section of Montezuma Creek. Molybdenum concentrations, which average approximately 0.09 mg/l immediately downstream from the site, exceed the recommended limit for agricultural use (National Academy of Sciences, 1972) by about a factor of ten. The creek is used both for irrigation and for livestock watering in the vicinity of the site.

Concentrations in the shallow aquifer generally exceed those found in the surface water. Uranium, molybdenum, vanadium, selenium, and arsenic are all found in concentrations exceeding 1 mg/l in some wells. However, because of the low volume of water in this aquifer, State of Utah standards are apparently not applicable.

Radon flux measurements were made on one of the tailings piles at Monticello. The average value was 500 pCi/m^2-sec compared with the Environmental Protection Agency (1983) standard of 20 pCi/m^2-sec. Air particulate measurements are preliminary since the monitoring network had only been in existence for one month. However, neither uranium nor radium-226 was detectable at concentrations of 0.0002 $\mu g/m^3$ and 1.5×10^{-4} pCi/m^3, respectively.

Various radiologic surveys were also performed in 1983. Results confirmed the presence of off-site contamination which could be either airborne or windborne as indicated by an earlier aerial survey. Based on these survey data, population dose commitments were calculated, but were found to be indistinguishable from background.

Section II

INTRODUCTION

This report describes environmental monitoring activities conducted at the U.S. Department of Energy (DOE) Grand Junction, Colorado, Area Office facility (Section III) and at the inactive uranium millsite in Monticello, Utah (Section IV).

GRAND JUNCTION AREA OFFICE FACILITY

The Grand Junction Area Office (GJAO) facility encompasses 48.6 acres and lies within the floodplain of the Gunnison River. An earthen dike separates the facility from the river on the west. Although adjacent land is used primarily for agriculture, the facility is within approximately 1 kilometer of heavily populated areas.

Personnel at the GJAO facility develop, support, and/or administer a variety of programs. Historically, the Office has been most heavily involved in uranium procurement, evaluation of domestic uranium resources, and advancement of geologic and geophysical exploration techniques. In recent years, the scope of activities has broadened to include provision of considerable support to the Government's various remedial action programs and to the National Waste Terminal Storage (NWTS) program. Housed on the GJAO facility are fully equipped laboratories for analytical chemistry, mineralogy-petrology, and electronics. Research groups at the facility have also received funding for specific projects from a variety of entities ranging from the Environmental Protection Agency to the Department of Defense. Bendix Field Engineering Corporation (Bendix) is the operating contractor for the Government-owned/contractor-operated (GOCO) facility.

No point-source discharges or waste-treatment activities occur on the facility. Uranium milling, analysis, and storage were conducted for a period of 25 to 30 years; these activities ceased in the mid-1970s. All present contamination is believed to be the result of these past activities. One area on the facility has been designated as containing buried tailings; however, results of several surveys (Allen and Abramiuk, 1982) indicate the presence of tailings and buried contaminated equipment at other locations. These buried wastes have resulted in contamination of the alluvial aquifer underlying the facility. The aquifer is believed to be the primary environmental concern and has been the major focus of monitoring activities.

Cleanup of the buried mill tailings at the GJAO facility has been accepted under the Surplus Facilities Management Program (SFMP). Funding for this effort will commence in FY-1986.

MONTICELLO, UTAH, MILLSITE

Responsibility for administration, maintenance, and environmental monitoring of the inactive uranium millsite and tailings area at Monticello, Utah, formerly operated by the Atomic Energy Commission, resides with the DOE Grand Junction Area Office. The site was accepted into the Surplus Facilities Management Program in 1980. Under this program, the chief objective of the Monticello Remedial Action Project is to minimize potential health hazards to the public associated with the tailings at the millsite. In order to provide a basis for making remedial-action decisions regarding the site, a preliminary environmental and engineering characterization was recently completed and is documented in the Site Analysis Report (Abramiuk and others, 1983).

The Monticello millsite is a 78-acre tract located in San Juan County, Utah, adjacent to the city limits of Monticello. The mill area covers approximately 10 acres and the tailings impoundment area covers the remaining 68 acres. None of the original mill buildings remain, but contaminated foundations and scrap materials are buried on-site. The tailings impoundment area contains almost 2 million tons of tailings and contaminated soil in four separate tailings piles.

Prior to 1955, the environmental problems receiving attention at the Monticello mill arose from the salt-roast procedure used to enhance vanadium recovery. Studies indicated that an average of nearly 2600 pounds of dust containing 0.363 percent U_3O_8 and 1.52 percent V_2O_5 escaped daily through the roaster stack (Allen and Klemenic, 1954). Corrosion of wire fences, clotheslines, and galvanized roofs was verified by the mill operator in response to complaints from local residents.

Liquid effluent from the salt roast/carbonate leach plant, containing substantial concentrations of chloride, sulfate, carbonate, bicarbonate, sodium, and other dissolved species, was released into Montezuma Creek. Release of radium-226 was of special concern; soluble radium activity in Montezuma Creek was found to be 160 pCi/l. It was also recognized that the suspended solids contained considerable radium activity and that dry tailings were being washed into the creek (Whitman and Beverly, 1958).

During milling operations, the tailings were normally moist so that erosion by wind was minimal. Within a year after shutdown, however, the tailings dams and surfaces of the piles dried out, and tailings sand began to migrate as dunes. Erosion by water also became a problem. Several cleanup activities, conducted since the time of mill closure, have substantially stabilized the area, but have not eliminated water contamination.

Water contamination results from the leaching of uranium mill tailings. Extensive studies conducted at Monticello (Abramiuk and others, 1983) demonstrate that all four tailings piles contribute to the contamination of groundwater and surface water, both on- and off-site.

QUALITY ASSURANCE

Quality Assurance (QA) measures were incorporated into all of the monitoring activities detailed in this report. The general QA plan is recorded in the GJAO/Bendix Quality Assurance Program Plan (Bendix Field Engineering Corporation, 1983). Documents that address QA considerations for specific measurements and sample-collection procedures are the GJAO/Bendix Analytical Laboratories Quality Assurance Manual (Bendix Field Engineering Corporation, 1984a), the GJAO/Bendix Handbook of Analytical and Sample-Preparation Methods (Bendix Field Engineering Corporation, 1984b), Procedures for Field Chemical Analyses (Korte and Ealey, 1983), Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells (Korte and Kearl, 1984), Procedures for Reconnaissance Stream-Sediment Sampling (Fleischhauer, 1984a), and Procedures for Sampling Radium-Contaminated Soils (Fleischhauer, 1984b).

Section III

GRAND JUNCTION, COLORADO, AREA OFFICE FACILITY

AIR QUALITY

No air-quality monitoring activities were conducted at the GJAO facility in 1983. The 1980 and 1981 environmental monitoring reports (BFEC-1981-3 and BFEC-1982-4, respectively) described air-quality impacts from the sample plant, analytical laboratory, employee automobiles, and the central heating plant. It was concluded that no impacts were observed or expected.

A large chamber for the study of radon measurements was recently constructed at the facility and is expected to release some radon to the environment. A study of the chamber, its uses and impact, will be conducted in 1984; results of the study will be included in the 1984 environmental monitoring report.

Other operations at the GJAO facility do not emit significant quantities of radiation into the atmosphere. The only major source of radon emission is the tailings buried on the facility. Results of radon flux measurements taken in 1979 indicate a possible violation of the Environmental Protection Agency (EPA) standard for inactive uranium mill tailings along the west boundary of the facility. However, these measurements are not now considered reliable. Additional measurements are planned when funding is available in FY-1986.

POLYCHLORINATED BIPHENYL (PCB) MONITORING

During 1982 a program was completed to identify and determine the total quantity of polychlorinated biphenyls (PCBs) and PCB-contaminated fluids on the facility. All facility transformers were opened and oil samples taken. These samples were analyzed in the Bendix Analytical Chemistry Laboratory, based on methods and standards provided by the Environmental Protection Agency. More than 1000 gallons of PCB-contaminated fluids were identified (Miller and Donivan, 1982).

All PCB-contaminated labware and waste material (approximately 20.5 pounds) were disposed of during 1983. The waste was shipped to ENSCO, Inc., in El Dorado, Arkansas (EPA ID No. AR0000404PCB). The carrier was U.S. Services, Inc., under permit H94PC793 (EPA ID No. AT080034259). Also during 1983 all PCB transformers on the facility were properly labeled and routinely monitored for leaks.

WATER QUALITY

SAMPLING PROCEDURES

Water samples were collected at the GJAO facility during the weeks of 21 March and 5 December, 1983. Both groundwater and surface water samples were obtained using a peristaltic pump. Samples were filtered through a 0.45-μm filter in-line with the collection vessel. The samples were then preserved and analyzed according to procedures prescribed in Korte and Ealey (1983) and Korte and Kearl (1984). These procedures incorporate the major aspects of procedures published by the Environmental Protection Agency (1979a, 1979b, 1980) and the U.S. Geological Survey (1977). However, they provide much greater detail and include extensive quality-assurance measures.

SURFACE WATER

Figure III-1 shows the surface water sites sampled in 1983; analytical data are contained in Appendix III-A. The North Pond is contaminated principally by uranium; recharge is primarily from the shallow gravel aquifer underlying the facility. Contamination levels are similar to those observed in previous years. Uranium concentrations in the two 1983 samplings averaged greater than 0.5 mg/l.

The South Pond, also recharged primarily by the shallow gravel aquifer, was formerly used as a sewage lagoon. Currently, its principal source of effluent is storm runoff from the parking lots. Only slight contamination by uranium has been observed; the average concentration of five samples taken over the period October 1981 through March 1983 was 0.012 mg/l. However, the sample collected in December 1983 contained nearly 0.1 mg/l. This elevated uranium concentration emphasizes the need for additional hydrologic tests to determine the reason for the fluctuation.

Previous environmental monitoring reports refer to a sampling location known as the drainage ditch. This area is located outside the facility fence directly west of the buried tailings area and below the river dike. Formerly, the South Pond overflowed into the ditch more or less continuously; however, it has been observed on numerous inspections that the pond has not contained sufficient water to overflow since the facility was connected to the city sewer system in 1981. Nevertheless, water remains in the ditch area except during very dry seasons. Results of chemical analysis of the ditchwater indicate some substantial fluctuations since the South Pond overflow ceased. Radium-226 was not detectable in 1982, but was as high as 59 pCi/l in 1983. The concentrations of uranium and molybdenum also remain very high, with the former exceeding 1 mg/l and the latter exceeding 0.2 mg/l.

The Gunnison River was sampled upstream, downstream, and alongside the facility in both March and December. Uranium-related contaminants were not detected in these samples, nor were significant differences in the three samples noted for either sampling period. Slight increases for a few ions are evident, but the differences are not sufficient to suggest contamination from the site.

The level of water in the ditch rises and falls with the level of water in the river; thus, there is a strong likelihood that contaminated water enters the river. Apparently, the volume of water in the river is sufficient to quickly dilute contaminants to background levels. The 1981 Environmental Monitoring Report (Korte and Thul, 1982) describes some weak evidence for river contamination; this is explained in part by the lower average flows in the river in 1981 relative to 1983. River flows for the sampling dates in 1983 were 2360 and 2130 cubic feet per second (cfs) for March and December, respectively.

An additional problem in assessing possible contamination of the Gunnison River results from the method used for sample collection. All the river samples have been "grab" samples collected from the riverbank; yet studies demonstrate that this type of sample does not yield an accurate picture of the concentration of material in a river (see, for example, Jaffe and others, 1982). A more extensive sampling study should be conducted to verify whether the river is affected by contaminants leaching from the GJAO facility.

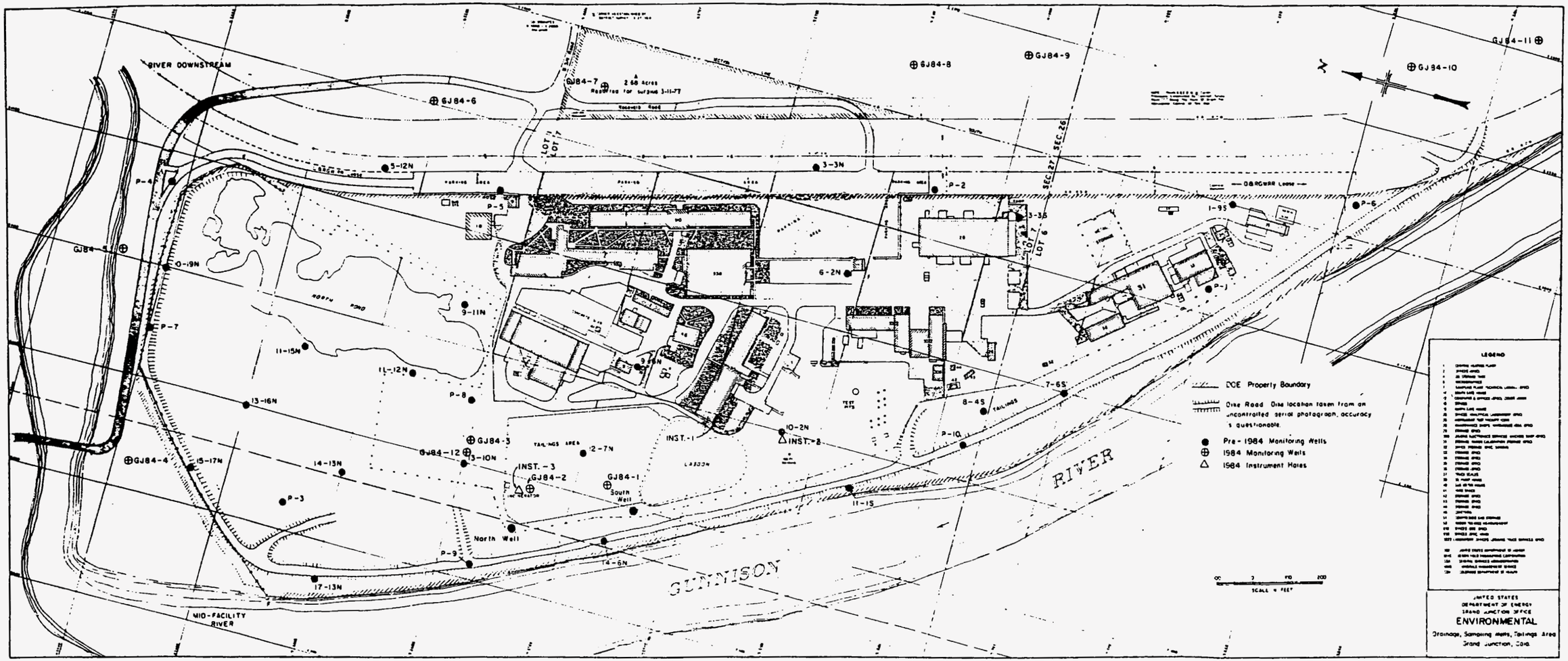


Figure III-1. Locations of Drainage, Sampling Wells, and Tailings Area at the Grand Junction Projects Office Facility

GROUNDWATER

Chemical analyses of samples from the groundwater monitoring wells are also described empirically; the data cannot be interpreted in a quantitative manner until additional hydrologic and chemical testing are completed.

Based on results of the 1981 data, wells P-2, P-6, 1-9S(D), 3-3N(D), and 5-12N(D) (Figure III-1) were expected to represent background. (The designation "D" refers to a two-well multilevel system at the particular location.) Results of subsequent samplings, however, indicate that this assumption is erroneous. Uranium levels in P-2 and P-6 reported in the 1981 report were less than 0.01 mg/l. During 1982 and 1983, samples from all five wells contained levels of uranium above the expected background concentration. Uranium contents ranged from approximately 0.03 mg/l in P-2 to more than 0.5 mg/l in the shallow well at location 1-9S. Except for the latter well, the concentration of uranium ranged from 0.03 to 0.06 mg/l. Other anomalies also exist. For example, selenium was detected in wells 5-12N(D) and 1-9S(D); contamination by zinc, vanadium, and manganese is evident in one or more wells. Thus, it is now believed that none of these five wells samples background. Additional wells are needed farther south of the facility; these will be in place during FY-1984.

It is possible that the consistently high water levels observed in the Gunnison River throughout 1982 and 1983 may have caused a gradient toward the east, resulting in movement of the contaminated aquifer into this group of wells. Were this true, sampling at low water levels might demonstrate a reversal, with the gradient toward the west and little or no evidence of contamination in these wells. Future funding will permit seasonal sampling such that river fluctuations and their effect on the aquifer can be determined.

The discussion that follows focuses on individual contaminants (cf. Figure III-1 and Appendix III-A for specific locations and concentrations).

Uranium contamination is evident in all wells. Eighteen wells contained more than 0.5 mg/l uranium in at least one of the sampling periods. The highest concentrations were found in wells 8-4S and 10-2N, located within the facility fence but west of building 30. The uranium levels in most of the other wells were greater than 0.1 mg/l. For example, the average concentration in wells P-4, 10-19N, P-7, and 15-17N along the north dike was 0.81 mg/l in 1982 and 0.88 in 1983. A striking difference was observed on the west boundary where wells P-9, 14-6N, 11-1S, P-10, 7-6S, and 8-4S averaged 0.88 mg/l in 1982, but increased to 1.32 mg/l in 1983. This increase correlates with the fluctuation in the South Pond noted earlier.

Molybdenum contamination is also widespread throughout the monitoring system. The highest concentrations were found in well 13-10N, just north of the buried tailings area. The concentration in this well was 0.7 mg/l in March and 0.69 mg/l in December. All the wells along the perimeter of the facility have detectable molybdenum. Of those on the dike, most had concentrations exceeding 0.2 mg/l.

Arsenic contamination is localized in the vicinity of the buried tailings area. A multilevel well pair is located on the dike between the buried tailings area and the river. Concentrations of arsenic in these wells, which

are within 4 meters of the river, were 0.13 to 0.4 mg/l in the two samplings. Two wells immediately to the north of the buried tailings area, 13-10N(D) and 11-12N(D), also showed detectable arsenic, but at levels less than 0.05 mg/l.

Selenium contamination is localized toward the south end of the facility. Highest levels were found in wells 3-3S, 10-2N, and 6-2N, which had concentrations slightly greater than 0.1 mg/l. Well 6-2N is just inside the facility fence near the parking lot, and well 10-2N is due west. Several other wells showed selenium contamination, most located south of well 6-2N. Wells along the dike generally showed selenium levels less than 0.01 mg/l.

Potential radium contamination is always a concern because of the nature of the buried waste. However, conditions of high pH, high sulfate, and low barium lead to little or no radium migration. This is, in fact, the case on the GJAO facility. Radium was detectable only in well 13-6N. This well is probably screened through tailings; thus, the sample may not be representative.

The drinking water standard for nitrate-nitrogen is 10 mg/l, and several wells showed concentrations exceeding this limit. All of these wells are located roughly between wells 8-4S (west of building 31) and 11-12N(D) (near the north lagoon). None of the perimeter wells contains high levels of nitrate.

COLORADO WATER-QUALITY STANDARDS

State of Colorado water-quality standards, as specified in the Colorado Water Quality Control Act, were reviewed with respect to contamination detected on the GJAO facility. Table III-1 presents the range of numerical standards for some of the contaminants found in the underlying gravel aquifer. There is no Colorado standard for molybdenum; however, the National Academy of Sciences (1972) has recommended an agricultural-use standard of 0.01 mg/l.

Table III-1. Colorado Water-Quality Standards for Selected Elements

Element	Maximum Contaminant Level (depending on use class and alkalinity)
Arsenic	0.05 - 0.1 mg/l
Selenium	0.01 - 0.05 mg/l
Uranium	0.03 - 1.4 mg/l
Radium-226 and -228	5.0 pCi/l

As the table demonstrates, application of these standards is complicated by the promulgation of varying contaminant levels for many trace elements, the applicable standard being dependent on the use classification and alkalinity of the water. The thrust of the Colorado statute is to clean up existing polluted waters and to prevent further degradation of any State waters. The shallow gravel aquifer underlying the GJAO facility is contaminated at levels that make it unfit for agricultural purposes, the lowest use class defined.

However, the language in the Act seems to exempt past practices. In other words, since the shallow aquifer is not being used for any purpose, it may be interpreted that the Department of Energy is not mandated to clean it up. On the other hand, existing operations are not permitted to cause further degradation.

Contamination of the Gunnison River is another matter. The regulations clearly prohibit any facility from degrading the quality of a State river. Hence, it is important to know how much contaminated water enters the river and whether the levels are increasing or decreasing. These questions can only be answered with additional hydrologic testing and geochemical modeling.

SUMMARY

Leaching of uranium mill tailings continues to contaminate the shallow aquifer underlying the GJAO facility. During 1983, uranium and radium concentrations in several samples increased. The close proximity to the river of high concentrations of uranium, molybdenum, selenium, and arsenic merits close continued monitoring. Available information from similar sites indicates that the effects of precipitation and dilution would cause the net effect on the river to be negligible.

Appendix III-A

1983 WATER-QUALITY DATA FOR THE U.S. DEPARTMENT OF ENERGY GRAND JUNCTION AREA OFFICE FACILITY

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 21 March 1983
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	mg/l Na	mg/l K	mg/l Ca	mg/l Mg	mg/l Si	mg/l Al	mg/l Ba	mg/l As	mg/l Mo
Well #6	MMQ 701	82839	326	7	78	16	8.6	<0.01	<.1	<.01	0.04
Gunnison upstream	MMQ 702	82840	52	3	71	30	5.4	0.01	<.1	<.01	<0.02
Lower Gunnison	MMQ 703	82841	53	3	69	30	5.3	0.04	<.1	<.01	<0.02
Middle Gunnison	MMQ 704	82842	53	3	67	30	5.5	0.02	<.1	<.01	<0.02
Ditch	MMQ 705	82843	123	21	109	29	2.5	0.01	<.1	.02	0.22
North Pond	MMQ 706	82844	850	25	350	200	0.8	0.06	<.1	<.01	0.03
South Pond	MMQ 707	82845	150	10	28	9	2.5	0.14	<.1	<.01	<0.02
#2A	MMQ 708	82846	261	8	203	57	8.2	0.01	<.1	<.01	<0.02
Well 3-3NA	MMQ 709	82847	451	11	309	59	10.4	<0.01	<.1	<.01	0.02
#3-3NB	MMQ 710	82848	435	10	210	59	11.5	<0.01	<.1	<.01	<0.02
#5-12NA	MMQ 711	82849	337	7	335	122	11.1	<0.01	<.1	<.01	<0.02
#5-12NB	MMQ 712	82850	282	7	304	107	11.8	<0.01	<.1	<.01	0.02
#3-3S	MMQ 714	82852	498	9	195	70	9.9	<0.01	<.1	<.01	<0.02
#6-2N	MMQ 715	82853	263	9	258	74	10.6	0.01	<.1	<.01	0.12
#9-6N	MMQ 716	82854	293	9	245	84	13.6	0.01	<.1	<.01	0.02
#10-2NB	MMQ 717	82855	334	14	367	105	8.8	<0.01	<.1	<.01	0.44
#10-2NA	MMQ 718	82856	600	12	267	111	9.2	0.01	<.1	<.01	0.31
#9-11N	MMQ 719	82857	362	9	241	80	12.7	<0.01	<.1	.02	0.03
#1-9SA	MMQ 720	82858	335	9	150	26	6.9	0.03	<.1	<.01	0.02
#1-9SB	MMQ 721	82859	183	8	171	39	8.3	0.09	<.1	<.01	0.03
#1A	MMQ 722	82860	288	7	174	36	5.4	<0.01	<.1	<.01	0.47
South Well 13-6A	MMQ 723	82861	126	14	146	37	10.8	0.01	.1	.01	<0.02
North Well 14-9N	MMQ 724	82862	142	14	99	17	7.8	0.02	<.1	.41	0.04
#12-7NA	MMQ 725	82863	133	12	134	31	13.5	0.02	.2	.07	0.02

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 21 March 1983 (continued)
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	mg/l Na	mg/l K	mg/l Ca	mg/l Mg	mg/l Si	mg/l Al	mg/l Ba	mg/l As	mg/l Mo
12-7NB	MMQ 726	82864	134	12	140	32	13.3	<0.01	.2	.05	<0.02
13-10N	MMQ 727	82865	197	12	180	25	9.7	0.06	<.1	.04	0.70
Well #8	MMQ 728	82866	301	8	244	79	12.8	<0.01	<.1	.02	0.02
#7-6S	MMQ 729	82867	113	3	91	36	10.2	0.02	<.1	<.01	0.20
#10	MMQ 730	82868	158	5	106	23	4.9	0.04	<.1	<.01	0.41
#8-4S	MMQ 731	82869	308	10	303	72	7.1	0.06	<.1	<.01	0.44
#11-1S	MMQ 732	82870	395	10	173	59	6.7	0.03	<.1	<.01	0.30
#14-6NB	MMQ 733	82871	86	10	92	19	9.0	0.03	<.1	.19	0.05
#14-6NA	MMQ 734	82872	95	16	74	16	10.1	<0.01	.1	.28	0.04
#9	MMQ 735	82873	68	5	101	23	6.9	0.01	<.1	<.01	0.29
#17-13N	MMQ 736	82874	112	4	85	25	7.3	0.02	<.1	<.01	0.04
#15-17N	MMQ 737	82875	750	13	212	48	7.8	0.10	<.1	<.01	0.51
#11-19N	MMQ 738	82876	1350	16	341	138	8.6	0.08	<.1	<.01	0.40
#7	MMQ 739	82877	750	11	174	39	8.6	0.85	<.1	<.01	0.37
#3B	MMQ 740	82878	1650	20	345	138	8.2	0.02	<.1	<.01	0.31
#3A	MMQ 741	82879	241	8	109	24	7.7	<0.01	<.1	<.01	0.13
#11-15N	MMQ 742	82880	800	15	550	170	9.6	0.03	<.1	<.01	0.24
#13-16NA	MMQ 744	82882	800	14	450	109	17.0	0.03	<.1	.01	0.02
#13-16NB	MMQ 745	82883	700	17	450	120	13.5	0.02	<.1	<.01	0.25
#14-13NA	MMQ 746	82884	289	9	196	48	10.9	0.02	<.1	<.01	0.28
#14-13NB	MMQ 747	82885	280	13	191	43	9.7	0.02	<.1	<.01	0.41
#11-12NA	MMQ 748	82886	319	10	255	76	12.6	0.02	<.1	.04	<0.02
#11-12NB	MMQ 749	82887	317	9	258	76	12.2	<0.01	<.1	.04	0.02
#4A	MMQ 750	82888	1250	22	450	250	8.0	0.02	<.1	<.01	0.10

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 21 March 1983 (continued)
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	mg/l NO_3-N	mg/l Cl	mg/l SO_4	mg/l Se	mg/l V	mg/l Zn	mg/l Mn	mg/l Fe	mg/l U
Well #6	MMQ 701	82839		22	700	<.01	<0.01	<.1	1.0	0.5	.034
Gunnison upstream	MMQ 702	82840		7	240	<.01	<0.01	<.1	<0.5	<0.1	.008
Lower Gunnison	MMQ 703	82841		8	240	<.01	<0.01	<.1	<0.5	0.1	.007
Middle Gunnison	MMQ 704	82842		6	210	<.01	<0.01	<.1	<0.5	<0.1	.006
Ditch	MMQ 705	82843		65	250	.01	0.02	<.1	<0.5	0.1	0.62
North Pond	MMQ 706	82844		320	2500	<.01	0.01	<.1	<0.5	0.1	.640
South Pond	MMQ 707	82845		150	94	<.01	0.01	<.1	<0.5	0.2	.019
#2A	MMQ 708	82846		39	950	<.01	<0.01	<.1	1.6	0.5	.030
Well 3-3NA	MMQ 709	82847		110	1600	<.01	<0.01	<.1	1.9	0.5	.029
#3-3NB	MMQ 710	82848		80	1200	.02	<0.01	<.1	0.6	0.1	.047
#5-12NA	MMQ 711	82849		180	1400	.01	<0.01	<.1	0.6	<0.1	.059
#5-12NB	MMQ 712	82850		160	1200	.01	<0.01	<.1	<0.5	0.1	.058
#3-3S	MMQ 714	82852		100	1100	.08	<0.01	<.1	0.8	<0.1	.046
#6-2N	MMQ 715	82853	11	110	950	.13	0.01	<.1	1.5	<0.1	0.86
#9-6N	MMQ 716	82854	15	180	920	.05	0.03	<.1	<0.5	<0.1	.360
#10-2NB	MMQ 717	82855	31	200	1600	.10	<0.01	<.1	2.4	<0.1	1.2
#10-2NA	MMQ 718	82856	10	160	1600	.06	<0.01	<.1	1.9	<0.1	1.3
#9-11N	MMQ 719	82857	13	170	1000	.04	0.69	<.1	<0.5	<0.1	0.50
#1-9SA	MMQ 720	82858	<5	31	820	<.01	<0.01	<.1	0.6	0.1	.036
#1-9SB	MMQ 721	82859	<5	31	680	.03	0.01	<.1	0.6	<0.1	0.50
#1A	MMQ 722	82860	<5	85	800	.05	<0.01	<.1	0.9	<0.1	0.86
South Well 13-6A	MMQ 723	82861		100	280	<.01	0.01	<.1	4.3	1.0	.004
North Well 14-9N	MMQ 724	82862		38	290	<.01	0.02	<.1	3.8	1.0	.110
#12-7NA	MMQ 725	82863		140	100	<.01	<0.01	<.1	4.2	0.3	.003

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 21 March 1983 (continued)
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	mg/l NO_3-N	mg/l Cl	mg/l SO_4	mg/l Se	mg/l V	mg/l Zn	mg/l Mn	mg/l Fe	mg/l U
#12-7NB	MMQ 726	82864		120	110	<.01	<0.01	<.1	4.3	0.8	.003
#13-10N	MMQ 727	82865		110	470	<.01	0.02	<.1	4.2	4.9	0.88
Well #8	MMQ 728	82866	16	140	950	.03	0.14	<.1	<0.5	<0.1	.410
#7-6S	MMQ 729	82867	< 5	14	360	<.01	<0.01	<.1	<0.5	0.1	.360
#10	MMQ 730	82868		11	440	<.01	0.05	<.1	1.8	0.9	0.73
#8-4S	MMQ 731	82869		94	1200	.09	0.21	<.1	1.7	0.1	1.1
#11-1S	MMQ 732	82870		130	1100	<.01	<0.01	<.1	0.7	0.1	0.62
#14-6NB	MMQ 733	82871		9	330	<.01	0.09	<.1	2.3	2.3	.160
#14-6NA	MMQ 734	82872		12	270	<.01	0.01	<.1	3.3	2.4	.054
#9	MMQ 735	82873		7	270	<.01	0.09	<.1	<0.5	0.2	.370
#17-13N	MMQ 736	82874		9	420	<.01	<0.01	<.1	1.5	0.1	.062
#15-17N	MMQ 737	82875		130	1900	<.01	<0.01	<.1	2.7	3.7	0.73
#11-19N	MMQ 738	82876		310	3500	<.01	<0.01	<.1	2.7	0.3	0.73
#7	MMQ 739	82877		110	1600	<.01	<0.01	<.1	1.8	0.1	0.73
#3B	MMQ 740	82878		130	4500	<.01	<0.01	.1	5.6	7.8	1.1
#3A	MMQ 741	82879		20	650	<.01	<0.01	<.1	2.2	0.9	.400
#11-15N	MMQ 742	82880		440	3000	<.01	<0.01	<.1	2.9	0.2	0.88
#13-16NA	MMQ 744	82882		240	1600	<.01	<0.01	<.1	5.3	3.0	.210
#13-16NB	MMQ 745	82883		250	2000	<.01	<0.01	<.1	8.1	5.3	0.58
#14-13NA	MMQ 746	82884		120	810	<.01	0.02	<.1	<0.5	0.2	.720
#14-13NB	MMQ 747	82885		120	720	<.01	0.01	<.1	1.8	0.5	0.51
#11-12NA	MMQ 748	82886	12	140	970	.03	0.18	<.1	0.5	0.1	.320
#11-12NB	MMQ 749	82887	12	140	1100	.03	0.18	<.1	0.6	<0.1	.350
#4A	MMQ 750	82888		480	4000	<.01	<0.01	<.1	3.9	0.3	0.51

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 21 March 1983 (continued)
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	pCi/l ^{226}Ra	mg/l PO_4-P	pH	$CaCO_3$/ mg/l ALKY	°C Temp	µmhos/ cm CDT
Well #6	MMQ 701	82839	<2.0	<0.050	7.8	250	13	1350
Gunnison upstream	MMQ 702	82840		<0.050	8.5	141	5	588
Lower Gunnison	MMQ 703	82841	<2.0	<0.050	8.5	138	5	602
Middle Gunnison	MMQ 704	82842		<0.050	8.4	134	5	602
Ditch	MMQ 705	82843	14	<0.050	8.0	319	7	1120
North Pond	MMQ 706	82844			8.4	285	10	5410
South Pond	MMQ 707	82845	<2.0		10.1	98	9	891
#2A	MMQ 708	82846			7.7	217	15	2210
Well 3-3NA	MMQ 709	82847			7.8	224	15	3100
#3-3NB	MMQ 710	82848			7.6	243	14	2750
#5-12NA	MMQ 711	82849		<0.050	7.4	324	14	3060
#5-12NB	MMQ 712	82850		<0.050	7.4	285	12	2650
#3-3S	MMQ 714	82852		<0.050	7.5	252	15	3360
#6-2N	MMQ 715	82853		<0.050	7.6	304	16	2580
#9-6N	MMQ 716	82854			7.2	345	18	2950
#10-2NB	MMQ 717	82855			7.3	308	14	3750
#10-2NA	MMQ 718	82856			7.2	332	13	3730
#9-11N	MMQ 719	82857			7.2	404	14	2720
#1-9SA	MMQ 720	82858			7.9	247	15	2160
#1-9B	MMQ 721	82859			7.7	220	14	1730
#1A	MMQ 722	82860			7.9	216	14	2130
South Well 13-6A	MMQ 723	82861	3.6		7.4	396	13	1390
North Well 14-9N	MMQ 724	82862	<2.0		7.7	253	12	1150
#12-7NA	MMQ 725	82863	<2.0		7.4	487	14	1400

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 21 March 1983 (continued)
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	pCi/l ^{226}Ra	mg/l PO_4-P	pH	$CaCO_3$/ mg/l ALKY	°C Temp	µmhos/ cm CDT
#12-7NB	MMQ 726	82864	<2.0		7.4	483	14	1460
#13-10N	MMQ 727	82865			7.4	370	12	1630
Well #8	MMQ 728	82866			7.2	355	12	2500
#7-6S	MMQ 729	82867			7.1	244	11	1060
#10	MMQ 730	82868			7.3	262	11	1250
#8-4S	MMQ 731	82869			7.1	280	9	2570
#11-1S	MMQ 732	82870			7.6	227	12	2140
#14-6NB	MMQ 733	82871			7.2	192	10	975
#14-6NA	MMQ 734	82872			7.4	196	10	910
#9	MMQ 735	82873			7.3	228	10	911
#17-13N	MMQ 736	82874		<0.050	7.7	157	11	1020
#15-17N	MMQ 737	82875		<0.050	7.6	392	11	4160
#11-19N	MMQ 738	82876		<0.050	7.5	554	10	5720
#7	MMQ 739	82877		<0.050	7.5	438	13	3400
#3B	MMQ 740	82878		<0.050	7.3	709	13	6260
#3A	MMQ 741	82879			7.6	208	14	1550
#11-15N	MMQ 742	82880			7.2	525	13	4720
#13-16NA	MMQ 744	82882						
#13-16NB	MMQ 745	82883			6.8	949	15	4360
#14-13NA	MMQ 746	82884			7.5	357	14	2170
#14-13NB	MMQ 747	82885			7.2	375	14	2050
#11-12NA	MMQ 748	82886			7.2	362	14	2560
#11-12NB	MMQ 749	82887			7.2	361	14	2440
#4A	MMQ 750	82888			7.3	493	15	

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 5 December 1983
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	mg/l Na	mg/l K	mg/l Ca	mg/l Mg	mg/l Fe	mg/l Mn	mg/l Zn	mg/l Si	mg/l Al	mg/l Ba
Upper Gunnison River	MMH 001	87419	50	3.0	74	30	<0.1	<0.05	0.05	6.6	<0.1	<0.1
#6	MMH 002	87420	330	8.3	89	17	0.5	1.4	0.05	10.2	<0.1	<0.1
2A Upper	MMH 003	87421	270	9.3	200	56	0.4	2.5	<0.05	10.2	<0.1	<0.1
Lower Gunnison River	MMH 004	87422	51	3.4	76	30	<0.1	<0.05	<0.05	7.0	<0.1	<0.1
Middle Gunnison River	MMH 005	87423	49	3.5	76	30	<0.1	<0.05	<0.05	6.8	<0.1	<0.1
3-3N Southhole lower	MMH 006	87424	440	12	310	57	0.8	2.9	0.25	12.3	<0.1	<0.1
3-3N Upper	MMH 007	87425	440	11	210	59	<0.1	0.55	0.10	12.9	<0.1	<0.1
5-12N A	MMH 008	87426	330	8.5	320	120	<0.1	0.82	0.10	12.5	<0.1	<0.1
5-12N B North hole	MMH 009	87427	310	8.7	340	120	<0.1	0.27	0.10	12.3	<0.1	<0.1
D-4 A	MMH 010	87428	1400	31	410	240	0.2	5.0	0.05	9.9	<0.1	<0.1
1-95 A	MMH 011	87429	350	10	150	26	<0.1	1.8	<0.05	7.1	<0.1	<0.1
1-95 B	MMH 012	87430	220	10	200	64	0.1	0.82	<0.05	12.3	<0.1	<0.1
#1 deep	MMH 013	87431	270	7.0	130	27	<0.1	1.0	<0.05	6.8	<0.1	<0.1
3-3 S	MMH 014	87432	510	11	210	78	<0.1	0.82	0.05	11.6	<0.1	<0.1
6-2 N	MMH 016	87434	280	11	250	71	<0.1	1.9	<0.05	10.4	<0.1	<0.1
10-2 N A	MMH 017	87435	830	21	480	190	<0.1	4.3	0.05	10.3	<0.1	<0.1
10-2 N B	MMH 018	87436	610	14	390	120	<0.1	3.2	<0.05	8.9	<0.1	<0.1
8-7 N	MMH 019	87437	270	8.7	140	51	<0.1	<0.05	<0.05	14.8	<0.1	<0.1
9-11 N	MMH 020	87438	390	10	230	80	<0.1	0.55	0.05	13.3	<0.1	<0.1
7-6 S	MMH 021	87439	330	7.5	180	71	<0.1	<0.05	0.05	10.6	<0.1	<0.1
8-4 S	MMH 022	87440	430	12	410	100	<0.1	3.0	0.05	8.2	<0.1	<0.1
11 1 S	MMH 023	87441	760	14	350	160	<0.1	0.27	0.05	8.8	<0.1	<0.1
14-6 N A	MMH 024	87442	160	21	110	23	2.5	5.2	<0.05	12.0	<0.1	<0.1
14-6 N B	MMH 025	87443	170	20	140	28	0.7	3.2	<0.05	10.2	<0.1	<0.1

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 5 December 1983 (continued)
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	mg/l Na	mg/l K	mg/l Ca	mg/l Mg	mg/l Fe	mg/l Mn	mg/l Zn	mg/l Si	mg/l Al	mg/l Ba
#10	MMH 026	87444	230	10	190	40	0.2	4.3	<0.05	5.9	<0.1	<0.1
#9	MMH 027	87445	110	6.0	130	35	0.1	0.82	<0.05	8.3	<0.1	<0.1
17-13 N	MMH 028	87446	180	6.9	240	66	<0.1	4.8	<0.05	8.5	<0.1	<0.1
15-17 N	MMH 029	87447	1100	20	270	71	6.1	4.7	<0.05	10.5	<0.1	<0.1
11-19 N	MMH 031	87449	1500	28	460	210	0.1	5.6	0.05	11.5	<0.1	<0.1
#7	MMH 032	87450	900	13	280	64	0.1	3.5	<0.05	10.0	<0.1	<0.1
#8	MMH 033	87451	310	11	210	69	<0.1	0.33	0.05	13.5	<0.1	<0.1
13-10 N	MMH 034	87452	250	21	240	34	1.2	7.2	0.05	11.8	<0.1	<0.1
14-8 N	MMH 035	87453	170	19	100	17	0.8	4.5	<0.05	11.3	<0.1	<0.1
12-7 N A	MMH 036	87454	180	15	220	50	0.6	8.4	<0.05	15.2	<0.1	0.3
12-7 N B	MMH 037	87455	180	18	230	51	1.0	8.5	<0.05	15.4	<0.1	0.3
South Pond	MMH 038	87456	200	12	93	28	0.1	<0.05	<0.05	1.6	<0.1	<0.1
13-6 N	MMH 039	87457	170	20	200	46	1.5	7.5	0.05	12.8	<0.1	0.2
Dike Ditch	MMH 040	87458	400	39	220	71	0.2	2.5	<0.05	6.0	<0.1	<0.1
14-13 N A	MMH 041	87459	360	13	220	52	0.1	<0.05	0.05	12.6	<0.1	<0.1
14-13 N B	MMH 042	87460	380	18	250	53	0.1	3.6	0.05	11.3	<0.1	<0.1
#3 South	MMH 043	87461	440	16	260	45	0.1	4.6	<0.05	9.6	<0.1	<0.1
#3 North Shallow	MMH 044	87462	480	14	190	73	1.7	4.0	0.05	9.8	<0.1	<0.1
11-15 N	MMH 045	87463	960	19	780	190	0.2	6.4	0.08	11.8	<0.1	<0.1
North Pond	MMH 046	87464	1200	33	340	240	<0.1	0.11	0.05	4.6	<0.1	<0.1
11-12 N A	MMH 047	87465	360	12	250	71	<0.1	0.65	0.13	14.3	<0.1	<0.1
11-12 N B	MMH 048	87466	350	12	250	72	<0.1	0.65	0.08	12.8	<0.1	<0.1
13-16 N A	MMH 049	87467	1800	29	670	190	4.6	11	<0.05	19.2	<0.1	<0.1
13-16 N B	MMH 050	87468	950	28	560	130	0.8	11	0.05	12.5	<0.1	<0.1

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 5 December 1983 (continued)
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	mg/l As	mg/l Mo	mg/l Se	mg/l V	mg/l U	mg/l Cl	mg/l NO_3	mg/l SO_4	pCi/l ^{226}Ra
Upper Gunnison River	MMH 001	87419	<0.01	<0.01	<0.01	<0.01	.008	7	2	290	
#6	MMH 002	87420	<0.01	0.02	<0.01	<0.01	.031	36	< 1	790	<2.0
2A Upper	MMH 003	87421	<0.01	<0.01	<0.01	<0.01	.037	48	< 1	1000	
Lower Gunnison River	MMH 004	87422	<0.01	<0.01	<0.01	<0.01	.007	7	< 1	290	
Middle Gunnison River	MMH 005	87423	<0.01	<0.01	<0.01	<0.01	.007	7	< 1	280	
3-3 N South hole lower	MMH 006	87424	<0.01	<0.01	<0.01	<0.01	.029	130	< 1	1700	
3-3 N Upper	MMH 007	87425	<0.01	<0.01	0.03	<0.01	.041	88	16	1400	
5-12 N A	MMH 008	87426	<0.01	0.01	0.01	<0.01	.061	200	2	1500	
5-12 N B North hole	MMH 009	87427	<0.01	0.01	0.01	<0.01	.080	200	< 1	1500	
D-4 A	MMH 010	87428	<0.01	0.02	<0.01	<0.01	.484	500	< 1	3800	<2.0
1-95 A	MMH 011	87429	<0.01	0.02	<0.01	<0.01	.086	45	2	960	
1-95 B	MMH 012	87430	<0.01	0.04	0.06	<0.01	0.7	42	16	890	
#1 Deep	MMH 013	87431	<0.01	0.33	0.02	<0.01	1.0	61	< 1	710	
3-3 S	MMH 014	87432	<0.01	0.01	0.05	0.01	.066	140	30	1500	
6-2 N	MMH 016	87434	<0.01	0.11	0.10	0.01	0.6	100	43	1100	
10-2 N A	MMH 017	87435	<0.01	0.15	0.08	<0.01	2.0	310	210	3000	
10-2 N B	MMH 018	87436	<0.01	0.38	0.06	<0.01	1.7	260	140	2200	
8-7 N	MMH 019	87437	<0.01	0.03	0.02	0.04	.400	72	42	610	
9-11 N	MMH 020	87438	0.02	0.03	0.03	0.79	0.5	210	55	1100	
7-6 S	MMH 021	87439	<0.01	0.24	0.05	0.01	1.4	82	77	960	<2.0
8-4 S	MMH 022	87440	<0.01	0.50	0.07	0.09	2.5	140	35	1900	
11 1 S	MMH 023	87441	<0.01	0.24	0.03	0.01	1.8	190	82	2800	<2.0
14-6 N A	MMH 024	87442	0.40	0.03	<0.01	<0.01	.056	49	< 1	420	<2.0
14-6 N B	MMH 025	87443	0.13	0.08	<0.01	0.11	.412	64	< 1	420	<2.0

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 5 December 1983 (continued)
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	mg/l As	mg/l Mo	mg/l Se	mg/l V	mg/l U	mg/l Cl	mg/l NO_3	mg/l SO_4	pCi/l ^{226}Ra
#10	MMH 026	87444	<0.01	0.43	<0.01	0.14	1.2	58	< 1	790	<2.0
#9	MMH 027	87445	<0.01	0.35	<0.01	0.12	.580	30	< 1	410	<2.0
17-13 N	MMH 028	87446	<0.01	0.02	<0.01	<0.01	.228	45	< 1	1000	<2.0
15-17 N	MMH 029	87447	<0.01	0.49	<0.01	<0.01	1.1	210	< 1	2800	<2.0
11-19 N	MMH 031	87449	<0.01	0.22	<0.01	<0.01	0.8	520	< 1	4100	<2.0
#7	MMH 032	87450	<0.01	0.27	<0.01	<0.01	1.0	240	< 1	2200	<2.0
#8	MMH 033	87451	0.02	0.02	0.04	0.16	.441	130	59	820	
13-10 N	MMH 034	87452	0.03	0.69	<0.01	0.02	1.3	120	< 1	820	
14-8 N	MMH 035	87453	0.52	0.04	<0.01	0.02	.049	39	< 1	420	<2.0
12-7 N A	MMH 036	87454	0.03	0.01	<0.01	<0.01	.006	170	< 1	520	<2.0
12-7 N B	MMH 037	87455	0.03	0.01	<0.01	<0.01	.005	160	< 1	530	<2.0
South Pond	MMH 038	87456	<0.01	<0.01	<0.01	<0.01	.093	170	< 1	410	<2.0
13-6 N	MMH 039	87457	0.16	<0.01	<0.01	0.02	.020	100	< 1	630	9.0
Dike Ditch	MMH 040	87458	0.04	0.13	<0.01	0.01	1.3	190	< 1	960	59
14-13 N A	MMH 041	87459	0.02	0.27	<0.01	0.03	0.5	140	< 1	960	
14-13 N B	MMH 042	87460	0.01	0.42	<0.01	0.03	0.8	130	< 1	1100	
#3 South	MMH 043	87461	<0.01	0.35	<0.01	<0.01	1.3	88	< 1	1400	
#3 North Shallow	MMH 044	87462	<0.01	0.08	<0.01	<0.01	0.6	53	< 1	1500	
11-14 N	MMH 045	87463	<0.01	0.27	<0.01	<0.01	2.1	590	< 1	3700	
North Pond	MMH 046	87464	<0.01	0.01	<0.01	0.01	.510	490	< 1	4000	
11-12 N A	MMH 047	87465	0.04	0.03	0.04	0.22	.402	140	76	990	<2.0
11-12 N B	MMH 048	87466	0.04	0.03	0.04	0.20	.395	130	63	1000	
13-16 N A	MMH 049	87467	<0.01	<0.01	<0.01	0.01	.243	730	< 1	3500	
13-16-N B	MMH 050	87468	0.01	0.40	<0.01	0.06	1.6	140	< 1	3300	

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 5 December 1983 (continued)
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	pH	µmhos/cm CDT *	mg/l $CaCO_3$ ALKY	°C Temp	ppm DO	Depth to H_2O
Upper Gunnison River	MMH 001	87419	8.5	602	183	5	9.9	
#6	MMH 002	87420	8.0	1732	252	14	1.0	10' 6"
2 A Upper	MMH 003	87421	7.9	2074	224	14	1.1	14' 4¼"
Lower Gunnison River	MMH 004	87422	8.9	611	130	4		
Middle Gunnison River	MMH 005	87423	9.0	611	146	4		
3-3 N South hole Lower	MMH 006	87424	7.9	2928	237	14	1.25	11' 1"
3-3 N Upper	MMH 007	87425	7.7	2662	256	14.5	1.30	10' 11"
5-12 N A	MMH 008	87426	7.4	2623	342	14	1.30	8' 7"
5-12 N B North hole	MMH 009	87427	7.4	2867	319	14	1.30	8' 3"
D-4 A	MMH 010	87428	7.4	6710	519	14	1.30	8' 1½"
1-95 A	MMH 011	87429	8.1	2257	251	13		13' 1"
1-95 B	MMH 012	87430	7.5	1989	284	14		12' 9½"
#1 deep	MMH 013	87431	8.1	1599	229	13.5		11' 5"
3-3 S	MMH 014	87432	7.6	3221	254	14		12' 3½"
6-2 N	MMH 016	87434	7.75	2440	281	14		13' 11½"
10-2 N A	MMH 017	87435	7.1	5055	371	13.5		11' 11"
10-2 N B	MMH 018	87436	7.3	3984	325	15		12'
8-7 N	MMH 019	87437	7.4	1972	394	17		11' 1-3/4"
9-11 N	MMH 020	87438	7.45	2664	410	15		10' 6½"
7-6 S	MMH 021	87439	7.2	2180	361	12	2.20	17' 6"
8-4 S	MMH 022	87440	7.2	3276	335	12	1.95	5' 8"
11 1 S	MMH 023	87441	7.3	4476	402	15		14' 10"
14-6 N A	MMH 024	87442	7.5	1086	288	16	1.35	16' 2"
14-6 N B	MMH 025	87443	7.4	1452	348	14		16' 9½"

* Value of CDT corrected to 25°C

Groundwater and Surface Water Monitoring Data for Samples Collected Week of 5 December 1983 (continued)
(Blank spaces indicate that no analytical data are available.)

Location		Lab No.	pH	µmhos cm * CDT	mg/l $CaCO_3$ ALKY	°C Temp	ppm DO	Depth to H_2O
#10	MMH 026	87444	7.45	1815	263	14.5		16' 4½"
#9	MMH 027	87445	7.3	1186	271	14.5		17' 5"
17-13 N	MMH 028	87446	7.7	1906	224	13.5		10' 4"
15-17 N	MMH 029	87447	7.55	4812	440	15		16' 4"
11-19 N	MMH 031	87449	7.5	7680	579	15		14'
#7	MMH 032	87450	7.5	4114	408	14.5	1.30	12' 10½"
#8	MMH 033	87451	7.7	2328	384	15		5' 3"
13-10 N	MMH 034	87452	7.4	2030	356	13.5		6' 5"
14-8 N	MMH 035	87453	7.5	1238	237	12.5		5' 11"
12-7 N A	MMH 036	87454	7.4	1944	536	15	1.30	7' 3½"
12-7 N B	MMH 037	87455	7.5	1920	457	15	1.25	7' 9½"
South Pond	MMH 038	87456	9.25	1136	125	4	12.4	
13-6 N	MMH 039	87457	7.6	1748	355	13		6'
Dike Ditch	MMH 040	87458	7.9	2304	506	3	5.7	
14-13 N A	MMH 041	87459	7.5	2342	386	11		7' 5"
14-13 N B	MMH 042	87460	7.4	2579	394	13		6' 9"
#3 South	MMH 043	87461	7.5	2725	362	12.5		4' 3"
#3 North Shallow	MMH 044	87462	7.6	2620	338	9.5		4' 2"
11-15 N	MMH 045	87463	7.3	6200	630	13	3.70	5' 3½"
North Pond	MMH 046	87464	8.55	5254	298	4	14.8	
11-12 N A	MMH 047	87465	7.4	2640	358	15		4' 3-3/4"
11-12 N B	MMH 048	87466	7.4	2558	369	13.5		4' 5"
13-16 N A	MMH 049	87467	6.8	7930	2095	14		5' 1½"
13-16 N B	MMH 050	87468	7.0	5088	541	15		5' 1½"

* Value of CDT corrected to 25°C

Section IV

MONTICELLO, UTAH, MILLSITE

WATER QUALITY

SAMPLING PROCEDURES

Groundwater and surface water samples were collected at the Monticello site either with a peristaltic pump or a bladder pump. Samples were filtered through a 0.45-μm filter in-line with the collection vessel. The samples were then preserved and analyzed according to procedures prescribed in Korte and Ealey (1983) and Korte and Kearl (1984). These procedures incorporate the major aspects of procedures published by the Environmental Protection Agency (1979a, 1979b, 1980) and the U.S. Geological Survey (1977). However, they provide much greater detail and include extensive quality-assurance measures.

SURFACE WATER

Characterization of Background

Background surface-water quality has been monitored for some years at the site labeled W-3 in Figure IV-1. This sampling point is located east of the culvert under Highway 163. Upstream samples (site I-1) have also been collected to verify that the W-3 site accurately represents the background water quality of Montezuma Creek (Korte and Thul, 1982).

From 1980 to the present, surface water at site W-3 has been characterized by low levels of toxic elements or mill-tailings-related contaminants. Elements not detected or found in very low concentrations include Ag, Al, As, Ba, Cd, Co, Cr, F, Fe, Hg, Mn, Mo, P, Pb, Se, U, V, and Zn. No Ra-228 has been detected. One out of ten samples was found to contain 5 pCi/l Ra-226; Ra-226 was not detectable in the other samples. The pH was found to be between 8 and 9; specific conductance was measured at 400 to 500 μmhos/cm, and alkalinity at 150 to 200 mg/l (as $CaCO_3$).

Surface Water Contamination

Permanent surface water on the Government property consists of perennial flow in Montezuma Creek and in the drainage between the carbonate and vanadium piles (drainage designated W-2 on the map in Figure IV-1). There is intermittent water in seeps south of the carbonate and vanadium piles and east of the acid pile. The vanadium and acid pile seeps contain water in the Spring following snowmelt. The seep adjacent to the vanadium pile generally covers an area up to 5 square meters to a depth of 15 to 30 centimeters. The acid pile seep is contained by a small dam and is, when full, approximately four times larger in area than the vanadium pile seep.

The seep adjacent to the carbonate pile forms a small pond covering approximately 15 square meters. This pond contains water throughout the Summer and supports a few cattails; it is the only one of the three seeps that contains water during the dry seasons. Table IV-1 presents data obtained from analyses of water taken from the seeps and the W-2 drainage; very high concentrations of several toxic elements are evident.

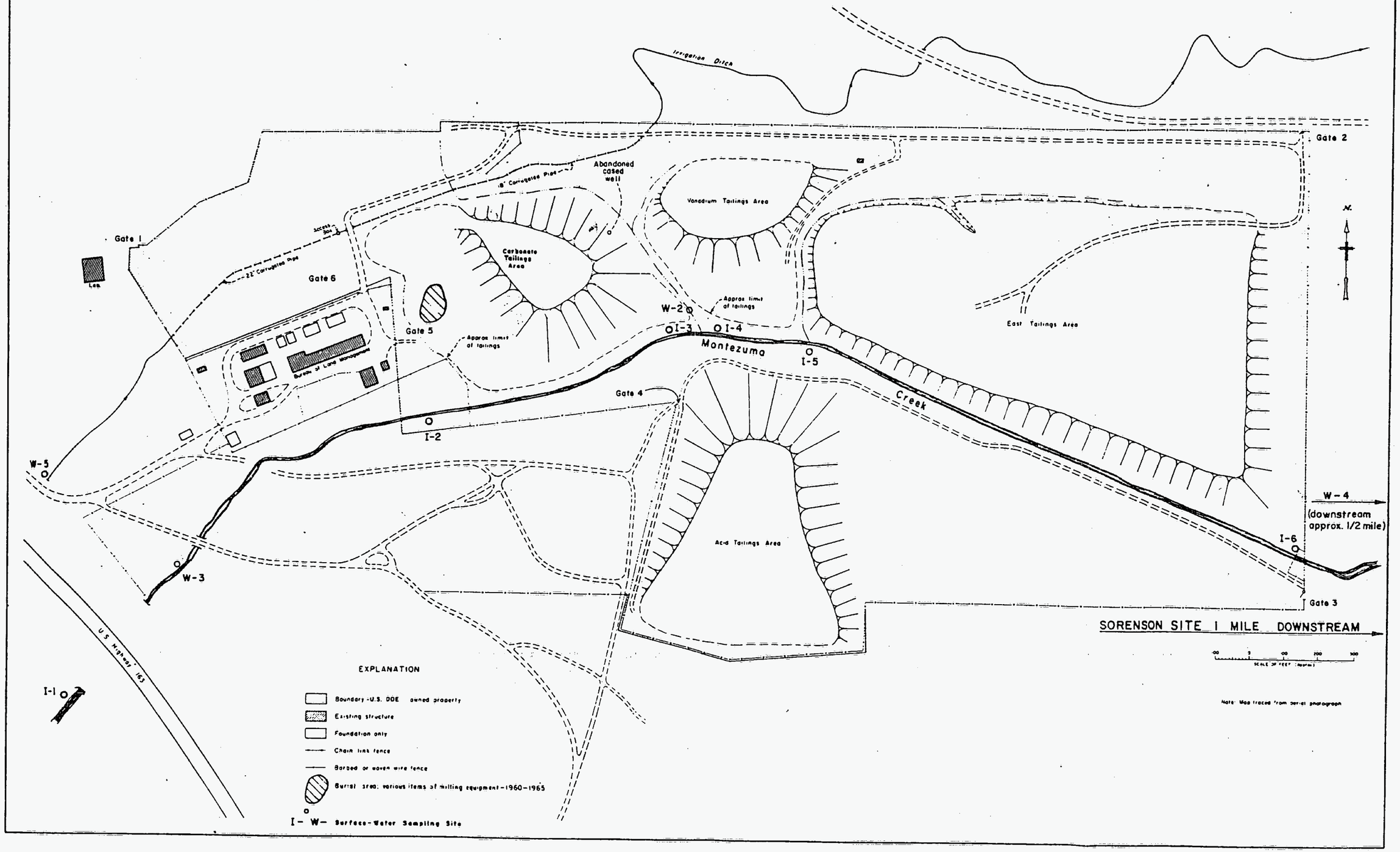


Figure IV-1. Sampling Locations for Surface Water at the Monticello Millsite

Table IV-1. Sample-Analysis Results from On-Site Seeps and Ponds

Sample Location	Contaminant Concentration[a]										
	As	Cl	Fe	Mn	Mo	NO_3-N	Ra-226	Se	SO_4	U	V
Seep Between Carbonate and Vanadium Piles (Site W-2)	0.56	946	—	0.08	4.1	47	4	0.63	2521	0.7	52
Seep Below Carbonate Pile	0.22	182	<0.1	3.8	4.5	8	<4	0.92	6405	1.7	54
Seep Below Vanadium Pile	26	890	0.34	295	26	<2	5	2.2	17,000	160	830
Pond East of Acid Pile	<0.05	42	<0.05	<0.1	2	51	17	0.037	1736	3.1	<0.05
Somerville Pond[b]	<0.05	<10	<1	<0.1	<0.05	<1	<2	<0.01	63	0.06	0.29

[a]All results are in mg/l except those for Ra-226 which are in pCi/l. Results represent averages from two to six samplings made over the period April 1982 to May 1983.

[b]The Somerville Pond is located just east of the tailings area.

Montezuma Creek flows through the middle of the property. Flow is perennial, although it can be quite low during the late Summer. There can also be substantial flooding with high flows, as was observed in the Spring of 1983. Results of previous studies (Korte and Thul, 1982) indicate that contamination of the creek with uranium is observed prior to the point at which the creek traverses the tailings piles. However, concentrations of both molybdenum and uranium are considerably higher off-site, demonstrating that the main contribution of the alluvial aquifer to Montezuma Creek occurs downstream from the Government property.

Somerville Pond

Of immediate concern is the stock pond on the Somerville property, which is directly adjacent to the east tailings area. Analytical results on this pond, which has been sampled on several occasions, are presented as the last entry in Table IV-1. Contamination by arsenic, molybdenum, vanadium, and particularly uranium is evident. However, the concentrations are lower by an order of magnitude than those found in the nearby creek or in the underlying shallow groundwater. The pond is filled with Montezuma Creek water from the top of a concrete drop structure near the site boundary; this is upstream from the portion of the creek where flow and contamination are increased by the shallow aquifer.

Montezuma Creek

Seeps from the shallow aquifer are visible along the creek below the drop structure. Creek flow increases for approximately 2 kilometers and is perennial along this stretch. Contamination also increases significantly (Table IV-2). The W-4 site is located approximately 100 meters downstream from the east boundary of the property. Except under conditions of very high flow, as during a storm event or Spring runoff, contamination levels frequently exceed State of Utah standards (see succeeding subsection, Water-Quality Standards).

Samples have routinely been collected at what is known as the Sorenson site, located approximately 2 kilometers downstream from the Government property. Analytical results from samples collected at that location are also presented in Table IV-2. It is apparent from data comparison that little decrease in contamination is observed between the W-4 site and the Sorenson site. The shallow aquifer is contaminated as far downstream as it has been sampled, and thus maintains high concentrations of the toxic elements in Montezuma Creek for a considerable distance off-site.

Samples have also been collected between the Sorenson site and the junction of Montezuma Creek and Montezuma Canyon. During August 1982, streamflow was intermittent from 1 kilometer below the Sorenson site to Montezuma Canyon. Flow was continuous when the area was resampled during July 1983. As observed in the August sampling, base flow showed no decrease in contamination. However, when flow is continuous, a dilution effect is soon observed, in that side canyons contribute to the flow of the creek. No contamination attributable to the side canyons was observed. The downstream water quality of Montezuma Creek is addressed in detail in the subsection that follows.

Table IV-2. Average Concentrations of Selected Toxic Elements in Montezuma Creek

Sample Location	Contaminant Concentration[a]									
	As	Fe	Mn	Mo	NO_3-N	Se	U	V	Zn	Gross Alpha
Background (Site W-3)	<0.01	<0.1	<0.05	<0.05	<5	<0.01	0.002	<0.05	<0.05	<2
Somerville Property (Site W-4)	0.01	<0.1	0.14	0.09	<5	0.013	0.65	0.39	<0.05	448
Butt (Sorenson) Property	<0.01	<0.1	0.12	0.06	<5	0.01	0.35	0.1	<0.05	242

[a]All results are in mg/l except those for gross alpha which are in pCi/l. Results represent averages from samples taken during twelve monitoring trips over the period August 1980 through May 1983.

Montezuma Canyon

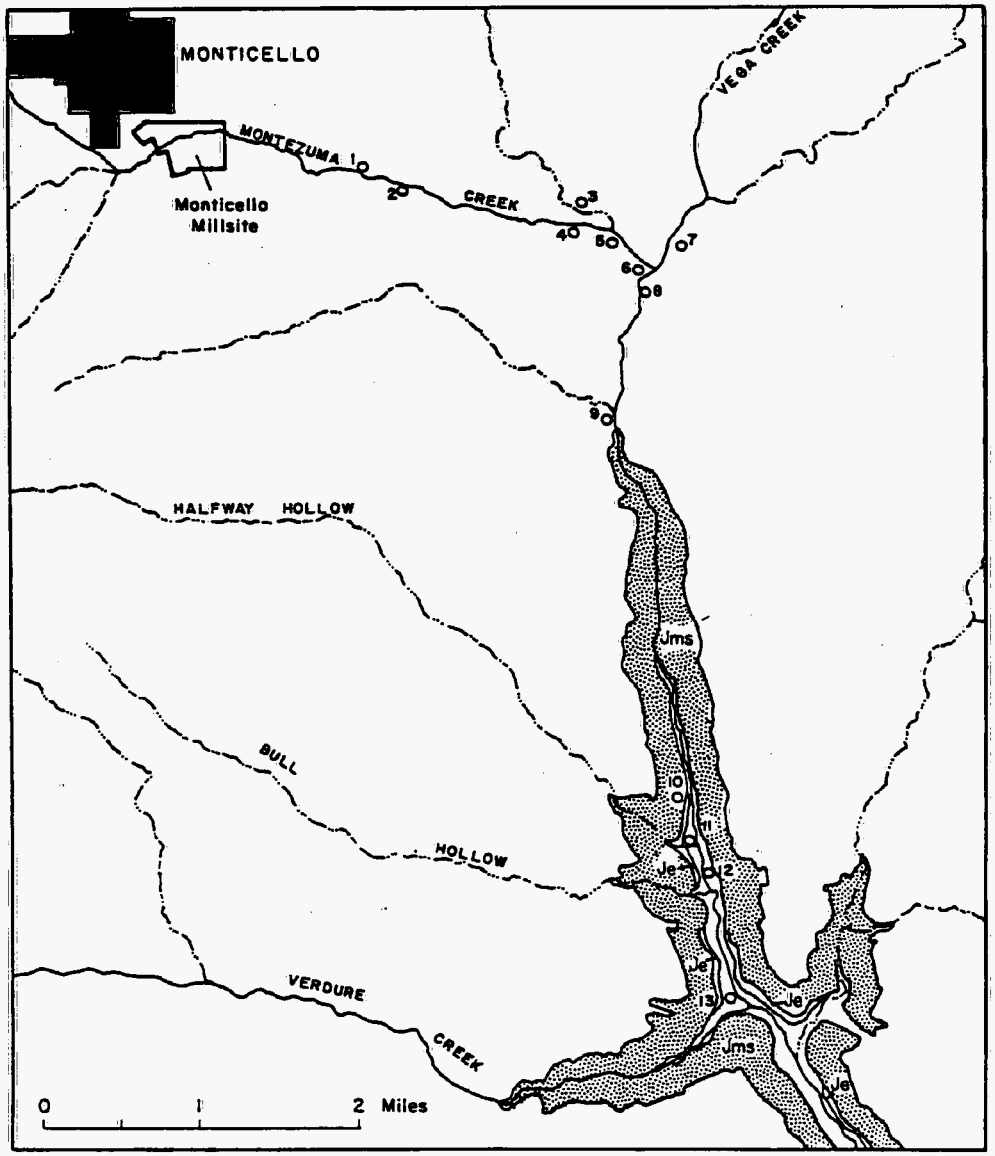
A study was undertaken to determine the extent to which off-site surface water contamination is attributable to the millsite. Environmental monitoring trips routinely include sampling at the Sorenson site, 2 kilometers below the piles, and at the bottom of Montezuma Canyon, 10 kilometers below the piles. The latter sample is collected just upstream from the confluence of Montezuma Creek with Verdure Creek, a point which has been designated the Montezuma Canyon site in previous environmental monitoring reports (Korte and Thul, 1982, 1983).

Samples were collected from Montezuma Creek at several locations between the Sorenson site and the Montezuma Canyon site in August 1982 and again in July 1983. Visual observations indicated that during August 1982 the creek flow was abnormally low. Streamflow was continuous for approximately 3 kilometers below the Government property. Flow was then intermittent up to 6 kilometers downstream from the site boundary, at which point flow increased significantly and remained continuous.

The water in the main canyon was sampled above and below each tributary to delineate possible uranium sources. Figure IV-2 presents the results obtained from sample analysis. In August 1982, uranium concentrations approximated 0.2 mg/l to the point that the creek begins to cut the Morrison Formation. Increases in uranium, molybdenum, and vanadium concentrations were observable below the Morrison. This is not surprising since uranium mineralization in the Morrison is common in the study area (Huff and Lesure, 1965). Contamination was not observed from any of the side canyons.

Table IV-3 displays uranium concentrations at the Sorenson and Montezuma Canyon sites over a 2-1/2-year period. Note that concentrations in August 1982 were anomalously low. Low concentrations were also observed in April 1983, when unusually high Spring runoff resulted in dilution of the contaminants. The August 1982 anomaly resulted from very low flow, with only base flow observed in intermittent pools; creek flow was simply not sufficient to carry the contamination downstream.

As Table IV-3 demonstrates, uranium concentrations at the Sorenson and Montezuma Canyon sites were more "typical" in July 1983 when the creek was sampled once again. Because other contaminants are sometimes observed in the creek, a few additional analyses were performed on the July 1983 samples. As noted above, molybdenum and vanadium were detected near the Morrison Formation in August 1982; these elements, along with selenium and arsenic, were not detected in any of the other samples collected. In July 1983, arsenic was not detected in any of the samples. Selenium was found in concentrations of 0.01 mg/l in the first two samples downstream from the Sorenson site, but was not detectable thereafter. The molybdenum concentration was 0.11 mg/l in the first sample downstream from the Sorenson site and showed progressive dilution to 0.05 mg/l when a slight contribution from the Morrison became evident. Vanadium showed the same pattern as uranium and molybdenum, decreasing from 0.09 mg/l to 0.04 mg/l in the lower canyon.



URANIUM CONCENTRATION(mg/l)

Sample Site	Aug 1982	July 1983
1	—	.51
2	.51	—
3	—	.006
4	.21	.25
5	.2	.31
6	.21	.42
7	.015	.002
8	.23	.23
9	.17	.18
10	.29	.31
11	.14	.12
12	.11	.17
13	.038	.22

Jms MORRISON - Salt Wash

Je ENTRADA

Note: Location 1 is on the Bailey property; Location 2 is the Sorenson sampling site; and Location 13 is the Montezuma Canyon sampling site. The Somerville property is adjacent to the east boundary of the millsite.

Figure IV-2. Sampling Locations and Associated Uranium Concentrations in Montezuma Creek (from Abramiuk and others, 1983)

Table IV-3. Uranium Concentrations at the Sorenson and Montezuma Canyon Sites, November 1981 to July 1983

Sample Date	Uranium Concentration (mg/l)	
	Sorenson Site	Montezuma Canyon Site
November 1981	0.85	0.19
April 1982	0.26	0.14
August 1982	0.1	0.038
October 1982	0.38	0.16
November 1982	0.38	0.18
April 1983	0.013	0.015
July 1983	0.51	0.22

The data from the July 1983 sampling trip, shown in Figure IV-2, depict the conditions which exist for most of the year. The most significant of these are the following:

- Seeps issuing from the contaminated alluvial aquifer increase the concentration of uranium in the creek by approximately an order of magnitude--up to several tenths of a milligram per liter. These seeps are most evident in the first 50 to 100 meters downstream from the Government property line.

- The Morrison Formation contributes significant amounts of uranium to Montezuma Creek at a point approximately 6.5 kilometers downstream from the piles. This contribution is responsible, in part, for maintaining the high uranium concentrations (Table IV-3) observed at the Montezuma Canyon site.

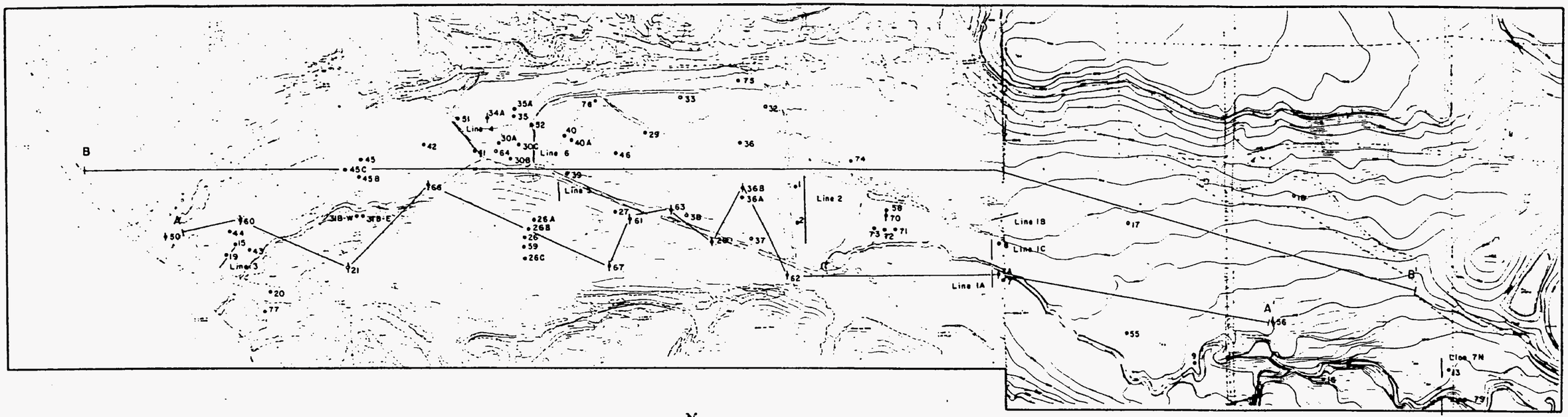
GROUNDWATER

Alluvial Aquifer Upgradient

Shallow-aquifer background groundwater quality data have been acquired from Wells 19, 44, 43, and 20 (see Figure IV-3). Elements not detected or found in very low concentrations include Ag, Al, As, Ba, Cd, Co, Cr, F, Fe, Hg, Mo, P, Pb, Se, V, and Ra. Trace elements found in significant concentrations include Mn (1.5 to 3 mg/l), Zn (0.05 to 0.2 mg/l), and U (as much as 0.07 ppb in two samples). The pH was found to range from 6.8 to 7.2; specific conductance was measured at 600 to 700 μmhos/cm, and alkalinity at 250 to 500 mg/l.

Alluvial Aquifer On-Site

The shallow aquifer is contaminated by the mill-tailings piles (Table IV-4). In general, the highest concentrations, including that of Ra-226 (Well 41), are found in the vicinity of the carbonate and vanadium piles. Note that the high uranium content of Well 36A on the east side of the east tailings pile is reflected in Wells 1 and 2 on the Somerville property.



EXPLANATION

A-A' Bedrock Cross Section

B-B' Generalized Cross Section

Line — Refraction Seismic Line

• Drill Hole

Core Hole

o Abandoned Drill Hole

N.

Figure IV-2. Sampling Locations for Groundwater at the Monticello Millsite

Table IV-4. Contamination in Shallow On-Site Monitoring Wells

Well No.	Contaminant Concentration[a]										
	As	Cl	Fe	Mn	Mo	NO_3-N	Ra-226	Se	SO_4	U	V
30A	0.02	72	0.19	3.1	0.09	<5	4.8	<0.01	400	0.21	0.36
30B	0.13	165	0.14	3.3	0.49	<5	<2	0.09	640	0.67	3.7
30C	0.11	140	0.37	2.2	0.38	<5	<2	0.11	560	0.37	3.5
36A	0.02	210	2.7	8.8	0.87	<5	16	<0.01	4230	3.2	<0.05
40A	0.06	130	0.27	2.5	0.34	<5	11	<0.01	625	0.97	0.86
41 (20 ft)	1.9	2460	<0.05	0.82	10.7	36	31	2.0	4490	1.9	106
45B	<0.01	20	1.0	1.7	<0.05	<5	<2	<0.01	240	0.03	<0.05

[a]All results are in mg/l except those for Ra-226 which are in pCi/l. Results represent averages from six samplings made over the period August 1982 to May 1983.

The on-site wells have also been checked for other elements and radionuclides. Those which were not detected or found only in very low concentrations include Ag, Ba, Cd, Cr, Pb, Hg, and Ra-228.

Alluvial Aquifer Downgradient

Somerville Property - The shallow-aquifer monitoring wells on the Somerville property are contaminated with uranium, molybdenum, vanadium, and selenium. The data presented in Table IV-5 demonstrate that concentrations of these elements remain high throughout the year. This aquifer is the major water source for the creek during the dry months, causing the creek to maintain relatively high levels of contamination during those periods.

Bailey Property - Table IV-5 also shows selected analytical data from similar wells on the Bailey property. These are located 1 kilometer east of the Government property, and are still significantly contaminated.

Contaminant Plume - Figure IV-4 shows the contaminant plumes that existed downgradient from the tailings piles in November 1982 and April 1983. Substantial increases in contaminant concentration levels were observed between those dates, probably because of low runoff in the Montezuma Creek watershed following the dry winter of 1981/1982. As a consequence, dilution of the groundwater by an influx of surface water was minimal, permitting the contaminant plume to migrate further downgradient. Both plumes appear to follow the historic stream channel adjacent to the east pile. As the contaminants continue downgradient, they become confined to the narrow alluvium bordering the present-day stream channel.

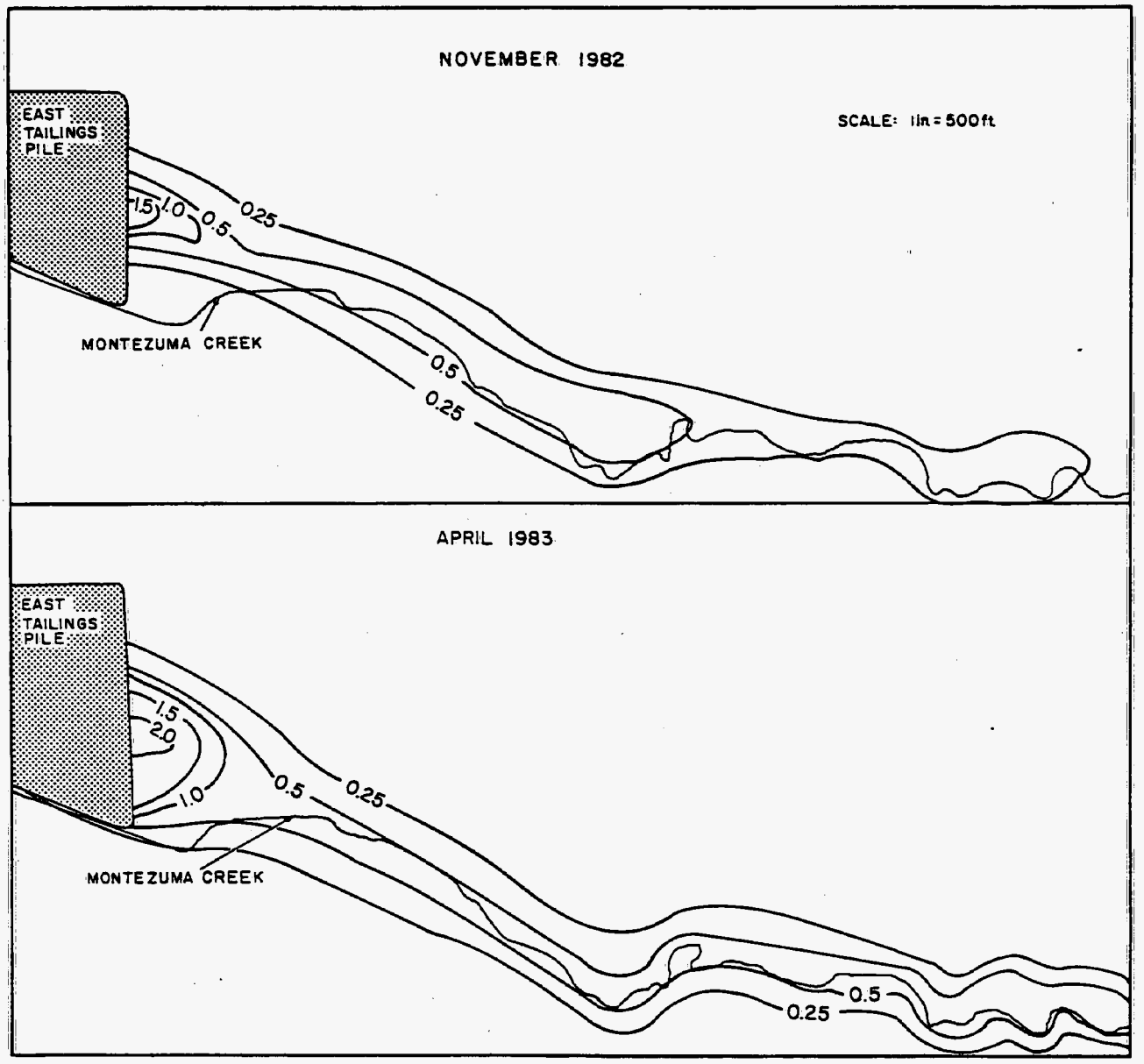


Figure IV-4. Contaminant Plumes for Uranium (in mg/l) Downgradient from the Tailings Piles in November 1982 and April 1983 (from Abramiuk and others, 1983)

Table IV-5. Contamination in Shallow Off-Site Monitoring Wells

Somerville Property

Well No.	Contaminant Concentration[a]								
	As	Fe	Mn	Mo	NO_3-N	Ra-226	Se	U	V
1	0.03	0.51	4.3	0.48	<5	<2	0.008	1.62	0.71
2	<0.01	0.11	1.2	0.12	<5	<2	<0.01	0.65	<0.05
7	<0.01	<0.1	0.9	0.05	<5	<2	0.04	0.39	0.24
8	<0.01	<0.05	<0.1	<0.05	<5	<2	0.04	0.31	<0.05
58	<0.01	<0.05	0.16	<0.05	<5	<2	0.035	0.39	0.35

Bailey Property

Well No.	Contaminant Concentration[a]								
	As	Fe	Mn	Mo	NO_3-N	Ra-226	Se	U	V
9	<0.01	0.15	2.1	0.08	<5	<2	<0.01	0.30	<0.05
13	<0.01	0.31	0.11	<0.05	<5	<2	<0.01	0.39	<0.05
16	<0.01	0.10	2.4	0.16	<5	<2	<0.01	0.1	<0.05
55	<0.01	0.2	3.6	0.15	<5	<4	0.02	0.33	<0.05

[a]All results are in mg/l except those for Ra-226 which are in pCi/l. Results represent averages from six samplings made over the period August 1982 to May 1983.

WATER-QUALITY STANDARDS

Inactive millsites owned by the Department of Energy are not governed by a specific set of standards or regulations with respect to pollution caused by the mill tailings or stabilization of the tailings piles. Instead, guidelines established for remedial action at DOE-owned facilities will depend upon the intended final use of the specific site.

The Surplus Facilities Management Program Office has directed that the following standards will apply to the surface-water and groundwater quality at Monticello (White, 1983):

- EPA Standards for Remedial Actions at Inactive Uranium Processing Sites (40 CFR Part 192)
- EPA Safe Drinking Water Act (40 CFR Parts 141, 142, and 143)

In addition, Executive Order 12088 mandates that Federal Government facilities comply with State standards. Thus, the Utah Water Pollution Control Act (1978) must also be addressed with respect to remedial action at the Monticello site.

Surface Water

According to the Utah Water Pollution Control Act, Montezuma Creek must be protected for domestic use (class 1C), aquatic life (class 3A), and agricultural use (class 4). The domestic-use classification is a result of drinking water being removed from the San Juan River at the town of Mexican Hat (Reichert, 1983); Montezuma Creek is a tributary of the San Juan.

Table IV-6 compares the average concentrations of the suspected hazardous contaminants found in Montezuma Creek with the applicable water-quality standards. Numerical standards have not been promulgated for some of the elements; thus, the potential violation of Utah's aquatic-life and agricultural-use standards is open to interpretation. A detailed discussion of potential health effects is contained in the Site Analysis Report (Abramiuk and others, 1983); the paragraphs that follow evaluate the concentrations of individual elements found in the surface water with respect to the relevant numerical standards.

Uranium - The State of Utah has established a standard of 15 pCi/l gross alpha for class 1C waters. Results of analyses of Montezuma Creek demonstrate that uranium is the only alpha emitter found in significant concentrations. Gross alpha, based only on the uranium contamination contributed by the piles, usually exceeds the standard by at least a factor of six for up to 10 kilometers downstream from the site. However, as described previously, after approximately 6.5 kilometers, there is a natural contribution from the Morrison Formation.

Arsenic - Arsenic contamination is detectable as far downstream as the Sorenson property. However, levels remain below the standards.

Selenium - Selenium concentrations usually exceed the standards for the first 3 kilometers downstream from the site. The highest concentration detected was three times the domestic-use standard, while the typical concentration approximately equals that standard.

Zinc - Zinc standards for the protection of aquatic life are apparently exceeded at times. Concentrations equivalent to two times these standards have been detected more than 2 kilometers downstream from the piles. However, the sporadic nature of these occurrences and the overall low average value indicate that zinc concentrations are usually less than the standards.

Radium-226 - Radium contamination has not been detected in any of the Montezuma Creek samples collected over the past year.

Molybdenum and Vanadium - Neither of these elements is subject to specific numerical standards. However, both are found in concentrations which may impair agricultural use.

Others - No other inorganic species are found in concentrations exceeding applicable State or Federal standards.

Table IV-6. Comparison of Montezuma Creek Contamination and Relevant Water-Quality Standards

Source	Contaminant Concentration[a]									
	As	Fe	Mn	Mo	NO_3-N	Se	U	V	Zn	Gross Alpha
MONTEZUMA CREEK CONTAMINATION										
Background (Site W-3)	<0.01	<0.1	<0.05	<0.05	<5	<0.01	0.002	<0.05	<0.05	<2
Somerville Property (Site W-4)	0.01	<0.1	0.14	0.09	<5	0.013	0.65	0.39	<0.05	448
Butt (Sorenson) Property	<0.01	<0.1	0.12	0.06	<5	0.01	0.35	0.1	<0.05	242
WATER-QUALITY STANDARDS										
Utah: Domestic Use (1C)	0.05	b	c	c	10	0.01	c	c	b	15
Utah: Aquatic Life (3A)	b	1.0	c	c	c	0.05	c	c	0.05	15[d]
Utah: Agriculture (4)	0.1	b	c	c	c	0.05	c	c	b	15[d]
Safe Drinking Water Act	0.05	c	c	c	10	0.01	c	c	c	c

[a] All results are in mg/l except for gross alpha which are in pCi/l. Results represent averages from samples taken during twelve monitoring trips over the period August 1980 through May 1983.

[b] Insufficient evidence to warrant establishment of a numerical standard; limits are assigned on a case-by-case basis (State of Utah, 1978).

[c] No legal guidance.

[d] Investigations should be conducted to acquire more information in areas where these pollution indicator levels are exceeded (State of Utah, 1978).

Groundwater

In general, contamination in the shallow aquifer is greater than that found in Montezuma Creek (cf. Tables IV-2, IV-4, and IV-5). Thus, the water is probably unfit for agricultural use. According to the Utah Water Pollution Control Act (1978), the class 1C designation applies if an aquifer contains "a sufficient quantity [of water] to supply a public system." Since all of the shallow wells yield only small amounts of water, the class 1C designation is not applicable to the shallow aquifer at Monticello.

Summary

State of Utah standards for surface water are clearly violated in Montezuma Creek as a result of contamination from the tailings piles. The shallow aquifer is even more contaminated, but contains too little water to have any potential for beneficial use.

AIR QUALITY

RADON FLUX AND ATMOSPHERIC TRANSPORT

Radon flux measurements were made at nine locations on the acid tailings pile on 27 July 1983. Each measurement was made over a 24-hour period during favorable weather conditions. The average of these short-term radon flux measurements on the acid pile was 500 pCi/m^2-sec. Results were later confirmed by obtaining four additional measurements on 18 August 1983. The average radon flux for the remaining three tailings piles was determined by normalizing the acid-pile data to measurements which had been made during 1981 (Korte and Thul, 1982). The resulting average radon flux value for each of the tailings piles is presented in Table IV-7. For disposal sites, annual average radon flux over the site may not exceed 20 pCi/m^2-sec (Environmental Protection Agency, 1983).

Table IV-7. Normalized Radon Flux Values for Each Tailings Pile at Monticello

Location	Radon Flux (pCi/m^2-sec)
Acid Pile	500
Vanadium Pile	675
Carbonate Pile	175
East Pile	200

Estimates of atmospheric dispersion of radon above background levels attributable to the Monticello tailings piles were calculated using the Atmospheric Transport Model (ATM), an area source computer model described by Raridon and others (1982). Input required by the computer model includes a measured radon flux source term (Table IV-7) and on-site meteorologic data with respect to wind velocity and direction. Atmospheric radon concentrations at a height of

1 meter above ground level were calculated for a distance of up to 2 kilometers from the center of each tailings pile at a total of 212 receptor points. The concentrations at each receptor point, attributable to each pile, were then summed and hand contoured.

A preliminary comparison of predicted and measured on-pile concentrations is presented in Table IV-8. The radon concentration measurements reported by Shearer and Sill (1969) represent the averages of a series of 48-hour samples collected at 3-week intervals from 3 August 1967 to 30 July 1968. Track Etch data collected at the same on-pile locations as those measured by Shearer and Sill represent the average radon concentrations during a 3-month period from 18 April 1983 to 21 July 1983.

The data presented in Table IV-8 demonstrate acceptable intercomparison results considering both the variety of techniques used and the number of intervening years since Shearer and Sill's work. In fact, their generally lower values may reflect the effect of disturbance on the covers of the piles during the last 14 years.

Additional measurements are planned for FY-1984 to verify these preliminary results. This work will include on-pile, site-boundary, and off-site Track Etch measurements as well as additional on-pile radon flux measurements.

Table IV-8. Comparison of Predicted and Measured On-Pile Radon Concentrations

Location	Radon Concentration (pCi/l)		
	Shearer and Sill	Track Etch[a]	Calculated[b]
Acid Pile	3.1	4.0	6.4
Vanadium Pile	2.4	6.2	7.7
Carbonate Pile	4.1	7.5	2.7
East Pile	4.5	3.6	3.4

[a]Track Etch method from Alter and Price (1981).

[b]Predicted concentrations include 0.34 pCi/l background as reported by Shearer and Sill (1969).

AIR PARTICULATES

The background particulate burden in the Monticello area can be inferred from information gathered at rural sites throughout the western United States (Flocchini and others, 1981; Hall, 1981; Korte and Moyers, 1978; Mesa County, Colorado, Health Department, 1979). In two of these studies (Flocchini and others and Mesa County, Colorado, Health Department), data were collected within 50 to 100 miles of Monticello. Results of all of the investigations demonstrate that the average particulate mass in western, rural, high-desert locations is 15 to 25 $\mu g/m^3$. These studies agree that most of the particu-

late mass is soil material, with only minor contributions of anthropogenic origin. However, determination of contaminants related to uranium mill tailings was not addressed in any of these investigations.

Van De Steeg and others (1982) describe the concentration and distribution of radionuclides in airborne particulates from the Ambrosia Lake uranium district in New Mexico. Average concentrations at background locations were approximately 5 to 10 $\mu g/m^3$ of U-238 and 0.1 to 0.5 pCi/m^3 of Ra-226. These values represent the closest approximation of a historical record for Monticello.

Sampling Method and Results

Inhalable particulate samplers based on the design by Wedding (1982) were installed at the Monticello site. The samplers are Sierra-Anderson Series 300, equipped with constant-flow controllers, mechanical timers, and Series-320-size selective inlets. Flow-rate calibration is accomplished with a Kurz Model 341 electronic mass flowmeter.

Samplers are operated at 40 cubic feet per minute (cfm) for 24 hours, running midnight-to-midnight every third day. Sample collection media are Whatman Number 40 cellulose filters or Pallflex-type 2500 quartz filters.

Wind-rose data collected on-site clearly identified two principal wind vectors in the area, one to the east and one to the north. Thus, sampling stations were located along these two directions as well as at a background site.

The background site (Water Plant Site) is located approximately 0.8 kilometer west of the City of Monticello near the pumphouse building for the city water supply. The intake port for this sampler is 3 meters above ground level. The area west of this site is mostly natural desert and mountainous terrain. There are no nearby industrial activities.

The east site (Somerville Site) is located on the eastern edge of the east tailings pile. The sampler was placed on a steel tower such that the intake was mounted approximately 3 meters above ground level.

The north site (Cemetery Site) is located on the west side of the City of Monticello cemetery grounds. This location is 300 meters north of the tailings area at an elevation 100 meters above the piles. The sampler intake is 4 meters above ground level.

Air-particulate sampling was initiated in August 1983. Table IV-9 lists data for selected elements obtained during the first month of sampling. These results indicate a very clean air mass with no detectable uranium or radium. In fact, all results are well within concentrations measured at background locations as reported in the studies cited earlier. Concentrations at the Water Plant Site are consistently lower than for the other sites. However, the data indicate that the slightly elevated values at the other two sites are probably related to activities in the City of Monticello rather than to the tailings area. Because of the low results, future sampling will be performed only every sixth day. Sampling will also be suspended during the winter because of access problems.

Table IV-9. Concentrations of Selected Elements in Airborne Particulates

Element	Element Concentration ($\mu g/m^3$)[a]		
	Somerville Site	Cemetery Site	Water Plant Site
Cu	0.009	0.013	0.009
Pb	0.012	0.018	0.010
V	0.0014	0.0016	0.0011
Fe	0.23	0.26	0.22
K	0.21	0.24	0.21
Mn	0.006	0.006	0.005
U	<0.0002	<0.0002	<0.0002
Ra-226	$<1.5 \times 10^{-4}$	$<1.5 \times 10^{-4}$	$<1.5 \times 10^{-4}$

[a]Except Ra-226 which is expressed in pCi/m^3.

RADIOLOGIC SURVEYS

An aerial radiologic survey of the Monticello site was conducted in September 1980 (EG&G, Inc., 1981). Results of this survey indicate that contamination extends more than 600 meters north and 300 meters south of the Government property. The contaminated area includes the ore-stockpile sites (Figure IV-5) which have been subjected to two previous cleanup efforts. In addition, a narrow contaminant plume extends down the valley of Montezuma Creek for more than 3 kilometers from the east property line of the site. This contamination results from multiple sources, including roaster-stack releases, ore-stockpiling activities, wind and water erosion of tailings, and tailings-pond effluent.

Ground traverses using a hand-held exposure-rate meter were conducted to verify the aerial survey results. Considering the uncertainties involved, correspondence is reasonably good (cf. Section 6 in Abramiuk and others, 1983).

SOIL AND STREAM-SEDIMENT CONTAMINATION

Grab samples of soil were also collected, both on- and off-site, and analyzed for uranium and radium-226 to verify the extent of contamination indicated by the aerial radiologic survey. Because certain nonradioactive elements in the ore and tailings may present hazards to livestock, samples collected in pastures south and east of the site were also analyzed for several trace metals including Se and Mo. Selenium concentrations are all below the detection limit of 2 ppm. Radium-226 concentrations range from 1 pCi/g to 67 pCi/g. The maximum concentration of 67 pCi/g is located near an area indicated by the aerial survey results as being highly contaminated (35 to 70 $\mu R/hr$).

Uranium and molybdenum concentrations in the areas east and south of the site are high enough to be of concern from the standpoint of toxicity to livestock. Uranium concentrations in these areas average 11 ppm and molybdenum concentrations average about 8 ppm.

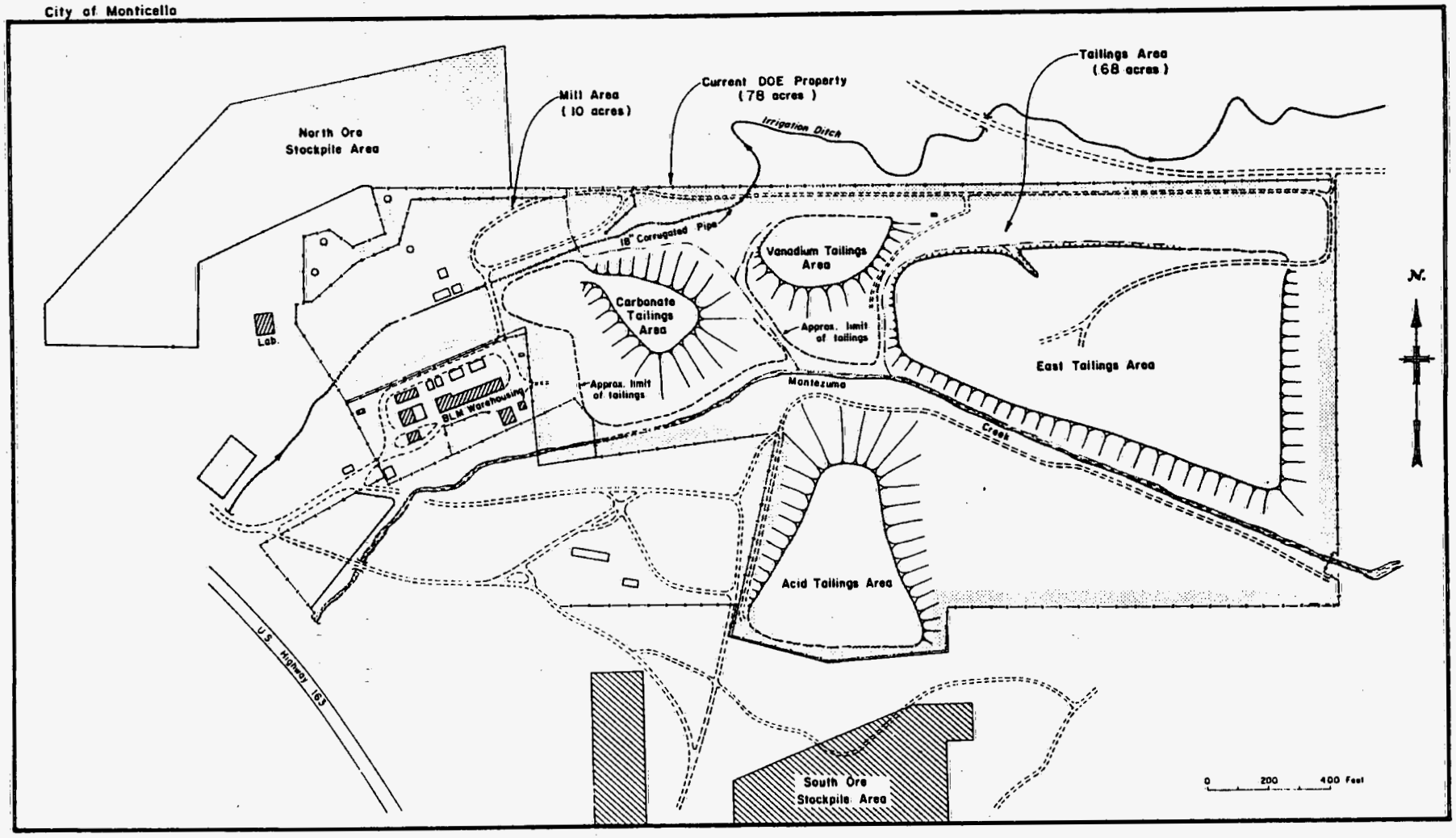


Figure IV-5. Monticello Millsite Plan (from Abramiuk and others, 1983)

Stream sediments were collected in Montezuma Creek from points upstream from the millsite down to the bottom of Montezuma Canyon. The background location averages <1 pCi/g Ra-226. Samples collected within the millsite to a distance of about 1 kilometer below the east boundary of the Government property average less than 5 pCi/g. From this point down to the confluence of Montezuma and Vega Creeks, averages range from 8 pCi/g to 25 pCi/g, with a maximum of 54 pCi/g for an individual sample. Below the confluence, the contaminated sediments are rapidly diluted, and no individual sample exceeds 4 pCi/g.

SUMMARY

The extent of off-site contamination indicated by the aerial radiologic survey (EG&G, Inc., 1981) and by historical data has been confirmed by the reconnaissance surveys described above. The persistence of radium contamination in the Montezuma Creek Valley is evident from soil and stream-sediment data. Although the levels in stream sediments are considerably below historical levels of contamination, numerous samples exceed current cleanup standards. The data also suggest that contamination remains in ore-stockpile areas despite two previous cleanup efforts.

POTENTIAL HEALTH EFFECTS

Population dose commitments and potential toxic effects of nonradiologic contaminants associated with the Monticello site were calculated and are described in the Site Analysis Report (Abramiuk and others, 1983). The resulting detrimental radiologic health effects were found to be indistinguishable from those resulting from background. However, remedial action will reduce the overall dose commitment to about 50 percent of the current level.

There is some potential for toxic effects from nonradiologic contaminants in the shallow unconfined aquifer and in Montezuma Creek. However, there have been no incidents reported. The potential for toxicity was derived from a comparison of contaminant levels with recommended safe limits as published in the technical literature (e.g., National Academy of Sciences, 1972). For example, the molybdenum concentration in Montezuma Creek for the first 2 kilometers downstream exceeds suggested limits for dairy cattle intake and may always exceed recommended limits for irrigation water. Selenium concentrations generally exceed the suggested limits for protection of dairy cattle and frequently exceed limits for irrigation water. Vanadium concentrations regularly exceed suggested limits for the protection of dairy cattle, aquatic life, and irrigation water. The suggested limits for beef cattle are also exceeded at times. Since the creek is used both for irrigation and for watering livestock, the potential for toxic effects merits further study.

CONCLUSIONS

Hydrologic conditions at Monticello result in the movement of contaminants into the underlying alluvial aquifer and downgradient from the tailings area. Remedial action will have to address the extensive contamination in Montezuma Creek. This contamination exceeds numerical standards set by the State of Utah and extends for at least 6.5 kilometers downstream from the millsite.

Section V

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